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VOL. CXXXVIII.—No. 3599] LONDON: FRIDAY EVENING, DECEMBER 19, 1924 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

The Engineer

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Railway Centenary in Austria.

PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, REQUIRES—
ELECTRIC CELLS for RAILWAY CARRIAGES, 9, 15 and 21 plate.
Tenders due on the 2nd January, 1925.
Tender forms obtainable from above. 7824

Assistant Locomotive SUPERINTENDENT REQUIRED for the NIGERIAN GOVERNMENT RAILWAY for two tours of from 12 to 18 months' service, with prospect of permanency. Salary £480 a year for the first three years, then £510, rising by annual increments of £30 to £720, and thence by annual increments of £40 to £920. Outfit allowance of £60 on first appointment. Free quarters and first class passages and liberal leave on full salary. Candidates, age 25 to 35, should be of good education, and preferably possess an approved Engineering Diploma. They should have had a thorough training in the workshops of a British Railway or well-known Locomotive Firm, should be conversant with the Repair and Erection of Locomotives, Carriages and Wagons, and be well up in Drawing-office Work, and have had Running Experience. Preference will be given to applicants who have acted in a supervising capacity.—Apply at once by letter stating age and particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/Nigeria 19,159. 7777

Draughtsman Required by the GOVERNMENT of the GOLD COAST, for the PUBLIC WORKS DEPARTMENT, for two tours of 12 to 16 months' service, with possible extension. Salary £480 for the first three years of service and then £510, rising to £720 a year by annual increments of £30, and thence to £800 by annual increments of £40. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. —Candidates, who should be between the age of 23 and 35, and Associates of the Royal Institute of British Architects, should apply at once in writing, stating age and giving brief details of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting clearly at head of application M/13,680. 7790

Executive Engineer Re- QUIRED by the GOVERNMENT of SIERRA LEONE, in the PUBLIC WORKS DEPARTMENT, for two tours of not less than 12 nor more than 18 months' continuous residential service. Salary £600 a year. Free quarters and passages and liberal leave on full salary. Candidates, aged 28-35, should have served articles with a Member of the Royal Institute of British Architects, and have passed the examination qualifying for Associate Membership of that Institute, or possess the Diploma of some recognised college which is accepted by that Institute as exempting candidates from taking the examination of the Institute. Must be first-class Draughtsman, capable of Designing and Carrying-out Buildings, Taking-out Quantities, Preparing Details and Specifications, and must be competent to Execute Building Surveys, Set out Buildings and Lay Out Roads. Other qualifications being equal, preference will be given to candidates who have had experience of the work of a Civil Engineer in the Construction and Carrying-out of General Public Works.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/13,190. 7776

Safety in Mines Research BOARD.
APPOINTMENT.
The Safety in Mines Research Board REQUIRES an INVESTIGATOR to Carry Out Work on the Strengths of Various Structures for the Support of Underground Workings in Coal Mines.
Applicants must possess a University Degree or its equivalent in Engineering. Preference will be given to ex-Service candidates.
The appointment is a temporary one in London for a period of one year, at an inclusive salary of £250 per annum.
Forms of application, which must be returned not later than 31st December, can be obtained from the UNDER-SECRETARY FOR MINES, Establishment Branch, Mines Department, Dean Stanley-street, London, S.W. 1. 7800

For Sale. SURPLUS GOVERNMENT ELECTRICAL STORES AT SHOEBURYNESS, ESSEX.
SIX D.C. MOTORS, 110 Volt, ¼ to 7·5 H.P.; ONE Portable PETROL SET, 8 K.W., 80-volt, 100 amps.; Feeder Cubicles, Feeder Panel, Oil Switches, Transformers, Ammeters, Fuses, Hand Switches, Table Lamps, &c.
The articles may be seen and lists giving details with forms of Tender, may be had on application to—
OFFICER-IN-CHARGE R.E. STORES,
Suttons Yar1,
7801 Shoeburyness.

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
Notice is Hereby Given that HENRY OLIVER HILL, of "Netherbrine," Newlyn, Penzance, SEEKS LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 222,742, entitled "Improvements in the Valve Mechanism of Sleeve Valve Internal Combustion Engines."
Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents), issued on the 10th December, 1924.
Any person, or persons, may give notice of opposition to the amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of the said Journal.
W. TEMPLE FRANKS,
P0924 Comptroller-General.

Metropolitan Asylums Board. The Board invite TENDERS for the OPENING OUT, REPAIRING and CLOSING UP of the ENGINES and AUXILIARY MACHINERY of the RIVER AMBULANCE STEAMER "MALTESE CROSS," in accordance with specification prepared by Mr. Thomas Cooper, M.I.C.E., M.I.M.E., Engineer-in Chief to the Board.
Specification, conditions of contract, and form of Tender may be obtained at the office of the Board Victoria Embankment, London, E.C. 4.
Tenders, addressed as directed on the form, must be delivered at the office of the Board not later than 10 a.m., on Wednesday, 31st December, 1924.
G. A. POWELL,
7789 Clerk to the Board.

PUBLIC NOTICES

Administrative County of LONDON.
DISPOSAL OF SECOND-HAND BOILER.
The London County Council invites OFFERS for the PURCHASE and REMOVAL from the Stores Department Depot at Portland-avenue, Stamford-hill, London, N. 16, of ONE SECOND-HAND BOILER to the following specification :—
Second-hand Multitubular Semi-portable Loco. Type Boiler, by Davey, Paxman; barrel, 9ft. 9in. by 3ft. 8in.; length of boiler, excluding smoke-box, 7ft. 7in.; fire-box casing, 3ft. 10in. wide, 4ft. 2in. deep, 6ft. 1in. high; 52 tubes, 2¼in. internal diameter; working pressure, 120 lb.; complete with feed pump, double lever safety valves, two water gauges, and one circular pressure gauge (300 lb.).
The boiler may be inspected at the depot on any week-day (except Saturday) between the hours of 10 a.m. and 4 p.m. on production of permit to view.
Applications for permits, as well as offers to purchase, must be addressed to the Chief Officer of Stores, The County Hall, Westminster Bridge, London, S.E. 1.
The Council does not bind itself to accept the highest or any offer.
Offers must be delivered at the County Hall by not later than 9 a.m. on Monday, 5th January, 1925.
JAMES BIRD,
7765 Clerk of the London County Council.

Bombay, Baroda, and Central INDIA RAILWAY COMPANY.
ELECTRIFICATION OF BOMBAY SUBURBAN LINES.
The Directors are prepared to receive TENDERS for the SUPPLY of the following PLANT :—
IMPEDANCE BONDS for TRACK CIRCUITING.
Fee for specification, £2 per copy.
Specifications and forms of Tender (which must be submitted in duplicate) may be obtained at this office on payment of the fee for the specification, which payment will not be returned.
Tenders must be sealed and addressed to the undersigned, marked "Tender for Impedance Bonds," and delivered not later than Noon on Tuesday, January 20th, 1925.
The fee should accompany any application by post. Cheques and postal orders should be crossed and made payable to the Bombay, Baroda and Central India Railway Company.
The Directors do not bind themselves to accept the lowest or any Tender.
The Consulting Engineers, to whom application for any further technical information may be made, are Messrs. Merz and McLellan, 32, Victoria-street, Westminster, S.W. 1.
S. G. S. YOUNG,
Secretary.
Offices: The White Mansion,
91, Petty France,
Westminster, S.W. 1,
18th December, 1924. 7825

County Borough of West Ham. WEST HAM MUNICIPAL COLLEGE.
ROMFORD-ROAD, STRATFORD, E. 15.
APPLICATIONS are INVITED for the POST of full-time ASSISTANT TEACHER in the Department of Engineering from candidates with University Degree and works experience. Salary in accordance with the Technical Burnham Scale for the London area, less 5 per cent., and subject to deduction for superannuation. Applicants must be members of a recognised teachers' organisation.
Forms of application may be obtained from the Principal, and should be returned not later than Monday, 5th January, 1925.
GEO. E. HILLEARY,
Town Clerk.
Education Department,
95, The Grove, Stratford, E. 15,
3rd December, 1924. 7733

PUBLIC NOTICES

City of Liverpool. TRAMWAY MATERIAL.
The Corporation are prepared to receive TENDERS for the SUPPLY and DELIVERY of—
COPPER BONDS.
TIMBER SLEEPERS.
Firms are requested to state clearly, when making application for the necessary Tender forms, the name of the material for which they desire to be furnished with Tender form.
Duplicate forms of Tender for record purposes will NOT be supplied.
Tender forms will be forwarded UPON RECEIPT OF APPLICATION IN WRITING to—
The City Engineer,
Municipal Buildings, Dale-street,
Liverpool.
Tenders must be sealed and enclosed in the official envelopes provided, endorsed in accordance with the instructions given on the form of Tender, and FORWARDED THROUGH THE POST, addressed to—
The Town Clerk,
Municipal Buildings, Liverpool.
LATEST TIME AND DATE FOR RECEIPT OF TENDERS.—TEN O'CLOCK A.M. ON FRIDAY, THE 2ND JANUARY, 1925.
WALTER MOON,
Town Clerk.
15th December, 1924. 7799

The Municipality of Singapore, STRAITS SETTLEMENTS.
WATER ENGINEER.
ADVERTISEMENT.
The Municipal Commissioners of Singapore REQUIRE a WATER ENGINEER, age 35-43, on a four years' agreement, with possible extension. Candidates must have had considerable experience, in a responsible capacity, of the design and maintenance of important waterworks, including impounding reservoirs, pumps, slow sand and mechanical filters, service reservoirs, detection of waste and the distribution of water throughout a large town. The selected candidate will be required to control the whole of the Water Department and to advise the Commissioners on all matters regarding the water supply of the city, apart from a large new water scheme now in progress under a Westminster firm of engineers. He must be a Corporate Member of the Institution of Civil Engineers, having responsible experience with a water company or the Water Department of a Public Authority. Administrative experience is an essential of this appointment. The population supplied with water is about 350,000 and the whole supply is impounded and pumped. There is a considerable area of open sand filters, but the filtration capacity is to be greatly extended and mechanical filters are under consideration. Two pumping engines, each of about 8½ million gallons per day, are about to be installed, with boilers and auxiliary plant. There is salt water pumping and distribution system. The total expenditure of the Water Department in 1923 was about £250,000 and the average daily consumption was nearly 11,000,000 gallons, of which a large portion is waste and must be reduced.
Salary 12,000 dollars for the first, 13,200 dollars for the second, 14,400 dollars for the third, and 15,600 dollars for the fourth year, paid monthly in dollars, the currency of the Colony, the value of the dollar being two shillings and fourpence sterling. The pay of the appointment for the first year at this rate would be £1400, rising to a maximum of about £1960 in 5 years. Such local transport allowance as may from time to time be sanctioned by the Commissioners will be paid. Free passage will be provided with half-pay during the voyage out. The selected candidate must pass a medical examination.
Applications, stating whether married or single, age, and place of birth, and giving details of education, training, and experience, particularly in waterworks, and referring to all the above requirements in detail, accompanied by copies (only) of testimonials, to be lodged with Messrs. C. C. LINDSAY and PEIRCE, MM. Inst. C.E., 180, Hope-street, Glasgow, Agents for the Commissioners, not later than Tuesday, 23rd December, 1924. 7721

PUBLIC NOTICES

County of London.
The London County Council invites TENDERS for the SUPPLY and DELIVERY in London of—
(a) About 5760 Tons of STANDARD STEEL GIRDER TRAMWAY TRACK RAILS, LIPLESS TRACK RAILS and FISH-BOLTS, and, alternatively, of about 4700 tons of such Rails and Bolts.
(b) About 700 Tons of CONDUCTOR TEE RAILS, the supply and delivery of which will form the subject of a separate contract.
Persons desiring to tender may obtain the drawings, specifications, bills of quantities, forms of Tender, and other particulars on application to the Chief Engineer of the Council, at the Old County Hall, Spring-gardens, S.W. 1, upon payment of the sum of £2 in each case. This amount is to be paid by cheque or draft to the order of the London County Council, and will be returnable if a bona fide Tender is submitted, and not subsequently withdrawn. All particulars may be obtained on application at the Old County Hall prior to the payment of this fee.
Tenders are to be delivered to the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1.
No Tender received after 4 p.m. on Monday, 19th January, 1925, will be considered.
The Council does not bind itself to accept the lowest or any Tender.
JAMES BIRD,
7818 Clerk of the London County Council.

Taf Fechan Water Supply Board. PIPE LAYING.—CONTRACT No. 3.
The Taf Fechan Water Supply Board are prepared to receive TENDERS from competent persons for the LAYING of about 21 Miles of STEEL and CAST IRON PIPES of 37in. and smaller diameters, together with ancillary works in the counties of Brecknock and Glamorgan, and for the CONSTRUCTION of a BREAK PRESSURE TANK.
Drawings may be seen, and instructions to tenderers and specifications and bill of quantities obtained, on and after the 22nd December, 1924, at the office of Sir Alex. Binnie, Son and Deacon, 20, Buckingham-gate, Westminster, S.W., on payment of a cheque for £5, made out to the Taf Fechan Water Supply Board, which amount will be returned on receipt of a bona fide Tender.
Sealed Tenders, endorsed "Tender for Pipe-laying," should be delivered at my office at or before Noon on Thursday, the Fifteenth day of January, 1925.
The Tenders so sent in are to be accompanied by the bill of quantities fully priced out, and the Board do not undertake to accept the lowest or any Tender, or to defray any expenses in connection with tendering, and will only consider such Tenders as are sent in by contractors who have previously executed works of a similar kind and magnitude.
J. COLENSO JONES,
Clerk to the Board.
Board's Offices,
101, High-street,
Merthyr Tydfil. 7780

Urban District Council of FLEET (HANTS).
EXTENSION OF EXISTING SEWERAGE AND SEWAGE DISPOSAL WORKS FOR FLEET.
UNEMPLOYMENT RELIEF WORKS.
GENERAL CONTRACT.
The Urban District Council of Fleet invite TENDERS from responsible and experienced contractors for the CONSTRUCTION of these WORKS, which comprise several miles of Cast Iron and Stoneware Sewers, Brick, Concrete and Cast Iron Manholes, Flushing Tanks, Ventilating Shafts and Columns, Cast Iron Rising Main, Air Mains, and additions to the Sewage Disposal Works, and other incidental work.
A copy of the specification and form of Tender, and bills of quantities may be obtained, and the drawings inspected, on and after a date to be communicated to persons tendering, on application, in writing, to Major T. J. Moss-Flower, Civil Engineer, 28, Victoria-street, Westminster, S.W., and Carlton Chambers, Bristol, at his Bristol office, on deposit of a £10 Bank of England Note, which will be refunded, provided a bona fide Tender be received, and is not withdrawn before the sealing by the Council of one of the Tenders, and provided also that all documents supplied be returned to the Engineer.
The Contractor carrying out the work will be required to comply with the regulations of the Unemployment Grants Committee with regard to the employment of labour during the performance of the contract, and the work must be actively commenced by the 12th January, 1925.
Sealed Tenders, endorsed "Tender for Fleet Sewerage and Sewage Disposal Works, General Contract," are to be delivered at the Council Offices, not later than Noon on the 7th January, 1925.
The lowest or any Tender will not necessarily be accepted.
Dated this 15th day of December, 1924.
(By Order),
ERNEST NASH,
Solicitor and Clerk to the Council.
Council Offices,
Fleet (Hants). 7785

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PUBLIC NOTICES

TO CONSTRUCTIONAL STEEL MANUFACTURERS.

The Fylde Water Board Invite

TENDERS from British manufacturers of repute for THREE STEEL TROUGH BRIDGES to carry Water Pipes.

The work to include both the manufacture and the erection of the bridges in their permanent positions.

The bridges are steel troughs, with covers, about 11ft. 6in. wide by 5ft. deep, with total lengths of 263ft., 153ft. and 121ft. respectively.

Full particulars and copies of the specification, drawings, &c., may be obtained from the undersigned on deposit of Five Guineas, which will be returned on receipt of a bona fide Tender.

Application to be made not later than January 7th, 1925.

Tenders, endorsed "Tender for Steel Bridges," must be addressed to the Engineer, Fylde Water Board, Sefton-street, Blackpool, and received on or before January 24th, 1925.

The Board do not undertake to accept the lowest or any Tender.

GEO. F. ATKINSON,
Engineer.

Head Office,
Sefton-street, Blackpool.
December 17th, 1924. 7815

Middlesex County Council.

ENGINEER'S AND SURVEYOR'S DEPARTMENT.

REQUIRED AT ONCE, TEMPORARY ENGINEERING ASSISTANT, accustomed to the complete design of Brick and Steel Railway Bridges.

Applications, stating experience and salary required, with copies of not more than three recent testimonials, to be sent to the undersigned not later than Saturday, December 20th, 1924.

A. DRYLAND,
County Engineer.

Guildhall, Westminster, S.W. 1.
8th December, 1924. 7734

SITUATIONS OPEN

REQUIRED, ENGINEER to Take Charge of Small Foundry, Machine Shop and Civil Construction Concern in Madeira; state qualifications, experience, languages and salary.—Address, P9921, The Engineer Office. P9921 A

REQUIRED for Portuguese West Africa, YOUNG ENGINEER, with experience in Sinking Bridge Foundations and General Railway Construction.—Write, stating salary required and giving recent references, to Box 213, c.o. Brown's, 39, Tothill-street, Westminster. 7783 A

TECHNICAL ASSISTANT WANTED for Aircraft Structural Calculations; sound theoretical training required, but previous aircraft experience not essential.—Apply, giving age, qualifications and salary required, to BOULTON and PAUL, Ltd., Norwich. 7779 A

THE NATIONAL OMNIBUS and TRANSPORT COMPANY, Limited, REQUIRE an ASSISTANT WORKS MANAGER, age about 30/35; Manufacturing Experience and good knowledge of Bodywork, Running Repairs and Maintenance of Rolling Stock essential.—Applications, giving full particulars of experience and salary required, to be addressed to THE SECRETARY, 306, Brompton-road, S.W. 3. Envelopes to be marked "AWM." 7770 A

WANTED, a Competent SHIP DRAUGHTSMAN, accustomed to ordinary Design and Stability Calculations.—Write, stating particulars of experience and salary required, to Z.A. 267, care Deacon's Advertising Offices, Leadenhall-street, London, E.C. 7814 A

WANTED, a STRUCTURAL DRAUGHTSMAN, able to Detail. State salary, experience.—Address, 7819, The Engineer Office. 7819 A

WANTED for South of England, Good JUNIOR ENGINE DRAUGHTSMEN, used to Marine or Turbine Work.—Address, 7774, The Engineer Office, stating salary required and giving particulars of experience, with copies of testimonials. 7774 A

WANTED for the North Midlands, DRAUGHTSMAN with experience in Steam Winders design and details, preferably with knowledge of Electric Winders. State age, detailed particulars of experience, and salary required.—Address, 7756, The Engineer Office. 7756 A

WANTED, Fully Experienced DRAUGHTSMAN, for Design of Vertical Crude Oil Engines, Semi-Diesel type. State fully experience, age and salary expected.—Address, 7769, The Engineer Office. 7769 A

WANTED Immediately, Competent DRAUGHTSMAN, accustomed to Boiler Plant Lay-out, for London area.—Address, 7811, The Engineer Office. 7811 A

WANTED Immediately, First-class DRAUGHTSMAN for large Motor Works in Lancashire; must be accustomed to Modern Design, the Preparation of Full-size Drawings and Detail Work in connection with 'Buses and other Passenger-carrying Vehicles.—Address, giving full particulars of experience, enclosing copies of references and stating age and wages required, 7804, The Engineer Office. 7804 A

DRAUGHTSMEN.—BEFORE NEGOTIATING with Government Departments in connection with any post, PLEASE COMMUNICATE with the GENERAL SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 90, St. George's-square, London, S.W. 1. 7817 A

DRAUGHTSMAN and DESIGNER REQUIRED in Country Engineering Works where General and Printing Machinery is manufactured; must have practical knowledge of Machine Work, as in part time would be required to inspect.—Address, 7798, The Engineer Office. 7798 A

DRAUGHTSMAN, JUNIOR, WANTED, for Jig and Tool Design; also experience essential; London district.—Write, stating age, experience and salary required, to Box No. 449, W. H. Smith and Son, Strand House, W.C. 2. P9918 A

DRAUGHTSMAN (MECHANICAL ENGINEERING) REQUIRED, with special knowledge of Electric and Compressed Air Haulages. State age, experience, salary required.—Apply, NORTONS (Tividale), Ltd., Tipton. Reference, Haulage Department. 7820 A

DRAUGHTSMAN REQUIRED, Engineering Firm in City, used to Piping Lay-outs; only experienced men need apply. State age, salary and experience.—Address, 7807, The Engineer Office. 7807 A

DRAUGHTSMAN REQUIRED for MACHINE TOOLS. Must be accurate and thoroughly reliable. Reply stating qualifications.—Address, "ALPHA," Wm. Porteous and Co., Advertising Agents, Glasgow. P9907 A

DRAUGHTSMAN WANTED for Ferro-concrete Work; one with Conveying and Elevating Experience preferred.—Address, stating age, experience and salary required, 7806, The Engineer Office. 7806 A

EXPERIENCED DRAUGHTSMAN REQUIRED, with knowledge of Cement and Crushing Machinery.—Apply, giving full particulars of age, experience and salary required, to W. J. C., Edgar Allen and Co., Ltd., Imperial Steel Works, Sheffield. 7778 A

REQUIRED, First-class CHIEF DRAUGHTSMAN to manage Drawing-office, about 30 men; must have experience Cranes, Conveyors, General Handling Machinery. State age, salary required, previous similar experience. All replies treated in strictest confidence.—Address, P9916, The Engineer Office. P9916 A

REQUIRED, First-class DRAUGHTSMAN, with experience in Centrifugal and Hydro-extractor Design.—Address, 7773, The Engineer Office. 7773 A

SITUATIONS OPEN (continued)

REQUIRED, EXPERIENCED DRAUGHTSMAN for Boiler and Superheater Work; thoroughly accustomed to Constructional and Detail Work.—Address, 7816, The Engineer Office. 7816 A

SENIOR DRAUGHTSMAN, with Experience in Detailing Heavy Rolling Mill Engines, Uniflow and Waterworks Pumping Engines. State age, experience and wages required.—Address, 7775, The Engineer Office. 7775 A

FOREMAN FITTER REQUIRED for Maintenance Work of a London Factory; Cranes, Heavy Grinding Mills, Conveyors, Boilers, &c.—Address, P9937, The Engineer Office. P9937 A

REQUIRED, SUBMARINE JOINTER, Fully Experienced in Making Splices in the Armour of the Cable over a completed joint. Ability to make the joint itself not essential.—Address, with copies of last two testimonials, 7821, The Engineer Office. 7821 A

SITUATIONS WANTED

WANTED, POST as ASSISTANT to Foundry Manager or Waterworks Engineer or Electrical Engineer, by young man, A.M.I.C.E., A.M.I. Mech. E. (Chartered Civil Engineer), with thorough knowledge of foundry work and general engineering, also expert in C.I. pipes; will accept £6 10s. per week or nearest for FUTURE prospects. Age 34 years.—Address, 7805, The Engineer Office. 7805 B

B.SC., STUD. INST. C.E., 2 Years Shops, Surveying experience, sound knowledge modern business methods and French, excellent refs., DESIRES SITUATION, home or abroad, any capacity. Commencing salary secondary if prospects good.—Address, P9898, The Engineer Office. P9898 B

ENGINEER, A.M.I. Mech. E., Over 18 Years' Experience in technical, practical and commercial, including continental experience in mechanical and electrical engineering, versed in works accountancy, good salesman, held responsible positions, OPEN to ENGAGEMENT.—Address, P9920, The Engineer Office. P9920 B

ENGINEER, Practical, Technical, Commercial, good organiser, (47), 30 years' experience home and abroad, OPEN to ACCEPT POSITION as Export Manager, home; alternatively, Manager or Representative, abroad.—Address, P9917, The Engineer Office. P9917 B

ENGINEER, Who has Spent 7 Years with Well-known firm of machine tool makers (4½ years training, 2½ years sales and publicity), WISHES to TAKE a RESPONSIBLE POSITION with a smaller firm. He has been well educated, partly in France, is thoroughly conscientious and a hard worker; has initiative and is acquainted with latest production methods and sales promotion.—Address, P9915, The Engineer Office. P9915 B

ENGINEER WORKS MANAGER DESIRES POST, Great Britain; 5 years' experience sugar refining, distilling, carbonic acid gas manufacture and production of aerated water machinery; 4 years' managerial position in India; experienced erection and working steam and oil-driven plant and electric installations; ex-officer R.E.—Address, P9922, The Engineer Office. P9922 B

ENGINEER, with 18 Years Modern Production, and planning, shop, tool design, D.O., and organising experience, DESIRES APPOINTMENT offering scope; experience aero., automobile, instruments, press work, &c.—Address, P9914, The Engineer Office. P9914 B

IRON, STEEL AND ENGINEERING SALESMAN.—Mr. J. PILKINGTON HUNT, having completed six years' engagement with Messrs. Hall and Pickles, Ltd., is now OPEN to DISCUSS the REPRESENTATION of a high-class FIRM in the Manchester and Lancashire area.—Confidential communications to be addressed c.o. The Engineers' Club, Manchester. P9874 B

MECHANICAL ENGINEER, with Experience as manager of general engineering works and boiler works, used to control of office, estimating, interviewing, designing, maintenance and repairs, is DESIROUS of OBTAINING SIMILAR ENGAGEMENT.—Address, P9906, The Engineer Office. P9906 B

PRACTICAL ENGINEER AND QUALIFIED DRAUGHTSMAN, with experience in keeping large factory plants efficient, and having just completed heavy dismantling job in engineering liquidation, DESIRES SITUATION; or as Representative of manufacturing firm for goods in shipbuilding and engineering trades, being well known to both. Willing to go British Colony or U.S.A.—Apply, D. F. BLACK, c.o. James Grimwood and Co., Incorporated Accountants, 2, Coleman-street, London, E.C. 2. 7802 B

RESIDENT ENGINEER or CONTRACTORS' AGENT, POSITION WANTED as; roads, bridges, docks, railways.—Address, P9880, The Engineer Office. P9880 B

SURVEYOR, Qualified in Surface and Mining Work, five years' all-round experience, DESIRES POSITION with Civil Engineering Firm or Harbour Board, with view to qualifying in engineering. Small salary required; excellent refs.—Address, P9926, The Engineer Office. P9926 B

DRAUGHTSMAN and ENGINEER, London, All-round experience, 10 years workshop, 12 years office, including patents and experimental work, or private work undertaken. Moderate salary.—Address, P9929, The Engineer Office. P9929 B

DRAUGHTSMAN (MECHANICAL), with Wide experience and good technical training, DESIRES PROGRESSIVE POSITION.—L., 50, Dynevor-road, London, N. 16 P9913 B

PARTNERSHIPS

IF YOU ARE SEEKING

A PARTNER or PARTNERSHIP

or wish to buy or sell a

BUSINESS or WORKS

Write:

WHEATLEY KIRK, PRICE & CO.,
46, Watling Street,
London, E.C. 4.
Established over 70 years.

ENGINEERS and MACHINISTS' BUSINESS FOR SALE, established 5 years in London, N.W.; good connection; capital required £1500. Alternatively, ONE PARTNER WOULD REMAIN, if income was suitable.—Address, P9912, The Engineer Office. P9912 C

£5000.—WANTED, AUSTRALIAN FIRM or GENTLEMAN, engineer preferred, to start MANUFACTURING ARTICLES in universal demand. German and American competition easily beaten. English works running successfully.—Address, P9890, The Engineer Office. P9890 C

MISCELLANEOUS

WANTED, a COPY of "THE PRACTICAL ENGINEER," Vol. 62, No. 1748, 1920.—Offers to G. E. STECHERT and CO., 2, Star-yard, W.C. 2. P9923

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Large selection of first-class machines in stock for disposal.
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For continuation of For Sale Advertisements see page 3.

A Seven-Day Journal

Further Locomotive and Rolling Stock Orders.

FOLLOWING our reference last week to the new programme of work announced by the London and North-Eastern Railway, comes the announcement that the London, Midland and Scottish Railway is to spend about £14,000,000 on extensions, renewals and maintenance during the coming year. Part of the work will be done in the company's own workshops and part by outside contractors and manufacturers. Provision has been made for the construction of 235 new locomotives, of which 220 will be of the large passenger type, the fifteen smaller being for the Tilbury and the Cathcart (Glasgow) services. Nearly £5,000,000 have been set aside for new coaches, 2591 in number, and 40 of the latest type of kitchen cars, while about 30,000 mineral trucks and refrigerated and hopper vehicles are to be built. Another large sum has been voted for the renewal of track, the strengthening of bridges, and the painting of stations. New work to be undertaken includes improvements at Holyhead in connection with the Irish cattle trade. The Holyhead Station is also to be reconstructed, as are stations at Westcliff-on-Sea, Bramhall, Blidworth, Birkdale and St. Pancras sub-station. During the present year several ships have been added to the L.M.S. fleet, and in the coming year a turbine steamer for the company's Clyde service is to be built and placed in commission.

The Port of Dover.

SINCE Dover Harbour was given over by the Admiralty for mercantile use, it has been quite clear that new shipping, other than the cross-Channel services, must be attracted if the historic town is to resume its place among British seaports. The drastic decision of the Southampton Harbour Board to levy, under the Southampton Harbour Act, 1924, a rate of a halfpenny per ton on vessels using, but not entering the port, would seem adversely to affect the fortunes of Southampton to the advantage of Dover. Already, we learn, the United American Lines and the Hamburg-American Line have signified their decision to adopt Dover as a port of call in preference to Southampton, for which port their programme was arranged. It is also quite possible that other companies, such as the North German Lloyd and the Rotterdam lines, may follow suit. Although the ships of these companies did not pay dues at Southampton, as they did not actually berth, considerable revenue was obtained from landing and tender charges and from stores bought at Southampton, which will mean a loss to that port. The first sailing from Dover under the new plan will take place on January 17th by the Albert Ballin. The Deutschland will sail on the 31st, and the Cleveland on February 15th. These liners will also use Dover as a port of call on the east-bound voyage.

Reconditioning the Leviathan.

AN effort is to be made apparently to increase the speed of the United States liner Leviathan by fitting her with new propellers during her winter overhaul and reconditioning. According to a correspondent of the *Journal of Commerce*, the new propellers will be of the three-bladed type, and will be of a slightly different pitch from those now employed. They are designed, we learn, from the results of experiments which have been made by American naval experts. It is estimated that with new propellers the speed of the ship may be increased by half a knot or the present average speed may be maintained with a saving of some 6000 shaft horse-power. We learn that the four-bladed propellers with which the liner is now equipped, and which represents pre-war practice, are now considered to be out of date. The new design of propeller will be slightly smaller than that which was used for the liner George Washington, belonging to the same company. The propellers for that ship measures 23ft. 3in. in diameter and has a weight of about 14 tons, making them the largest propellers ever constructed in America.

The Telephone Service.

THE Postmaster-General recently received a deputation from the Telephone Development Association, which is calling for a more intensive development of the telephone service. The Association's main contention is that in the race for industrial efficiency this country is considerably handicapped by the fact that it only possesses twenty-three telephones per thousand of its population as compared with thirty-five in Germany, eighty-three in Denmark, and one hundred and thirty-one in the United States. The Association urges the view that expenditure incurred in developing the telephone system is immediately reproductive, and that an increase in telephone density will give employment to a wide range of industries. To bring the British telephone service up to the Danish standard, this country needs another three million telephones. If the list of British telephone subscribers could be increased to this extent, unemployment might be considerably reduced. Not only would the firms manufacturing telephone material and apparatus require many more men, but the associated industries, such as those engaged in the manufacture of cables, conduits, insulators, &c., would also increase their staffs. An interesting fact in this connection is that last year more telephones were installed in the United States than there are in the whole of Great Britain.

Stour Valley Sewerage Extensions.

SOME important proposals for the extension of the works controlled by the Upper Stour Valley Main Sewerage Board were discussed at a meeting held on the 12th inst. The existing works, which are some thirty years old, are now insufficient in capacity to carry the maximum dry-weather flow, and consequently are altogether inadequate in wet weather. The engineer, Mr. W. Fiddian, proposes to overcome the difficulty by means of supplementary works, so that the existing system may be utilised to the best advantage. His scheme is to enlarge the sewage farm at Whittington from its present capacity of 3 million gallons to 8 million gallons a day. He recommends the provision of additional machinery to meet an increase in irrigation at the farm, the establishment of a pumping station at Hay Green, Lye, the erection of works for storm-water treatment on the land at Quarry Bank, and also for dealing with the sewage which is at present treated by the Stourbridge Main Drainage Board. The estimated cost of carrying out the works, including the purchase of land, easements, law and engineering charges, and supervision of construction, amounts to £75,000. The work will probably occupy two years, and will make provision for the needs of the area during the next thirty years.

British Beet Sugar Factories.

THE rapidity with which fresh schemes for the erection of beet sugar factories in this country are being promoted is so great that it is a little difficult to keep pace with them. Last week we announced that the group with which Lord Weir, Lord Invernairn and others are associated, which group already has a factory in existence at Nottingham, is to erect additional factories next year at Kidderminster and Spalding. We also reported that two other factories, at Ely and at Ipswich, were to be erected. These two factories, we learn, will be constructed by the Anglo-Dutch group, which controls the existing establishments at Cantley and Kelham. The Ipswich factory will serve the South Suffolk and Essex beet growers. It will have a capacity of 1200 tons of beet per day, and will manufacture white sugar and dried beet pulp. In addition to these schemes, yet another one is in hand for the erection of a factory at Bury St. Edmunds. The cost of this establishment, it is said, will exceed £350,000, and will be contributed to equally by British interests and a Hungarian group. Work on the site is to be begun next month, and it is hoped to have the factory ready to deal with next year's crop.

Steel Houses.

SPEAKING in Parliament on Tuesday, the Minister of Health, Mr. Neville Chamberlain, made an interesting statement regarding steel houses of the type in which Lord Weir and other engineers are at present greatly interested. He stated that a dwelling of this form was not unsightly, as some supposed it to be. It consisted of a timber frame carrying a steel exterior and lined internally with compressed wood fibre board. The cost of such a house, he continued, could not as yet be fixed, for it would be materially affected by the demand. If that demand became considerable, he foresaw the springing up all over the country of factories for the production of the standardised units that would be required. The new industry thus created would, he held, provide work for many thousands in the engineering trades, who were at present unemployed. He concluded by intimating that the Government was prepared to set aside a small grant to assist in the work of exhibiting sample steel houses in various parts of the country. It is noteworthy—and reminiscent of the introduction of other improvements in the past—that in Labour circles the steel house is viewed with suspicion and with evident fear that its coming will react upon the bricklayer's and plasterer's crafts.

A New American Airship.

THE Chief of the United States Naval Air Service, Rear-Admiral Moffatt, has reported to a Committee of Congress that his department is contemplating the construction of a new airship of 6,000,000 cubic feet gas capacity. This vessel, if constructed, would, it is estimated, have a "paying load" carrying capacity of 22 tons, and would be capable of performing forty trips annually between New York and London. The profit on its commercial operation on this route is very boldly, optimistically and meticulously set at 4,486,000 dollars a year, a figure which seems wildly extravagant in view of the fact that the highest estimated cost of building the vessel is 6,000,000 dollars. The airship would have a length of 785ft., a diameter of 120ft. to 130ft., a gross lifting capacity of 154 tons, and a cruising radius of 7150 nautical miles. Its engines would be of 3900 horse-power, and its maximum speed 70 knots. The vessel would have more than double the gas capacity of the ex-German Zeppelin Los Angeles—2,600,000 cubic feet—and would surpass by 1,000,000 cubic feet the capacity of the two airships now about to be built in this country.

The Port of Richborough.

ACCORDING to a statement made by the Mayor of Sandwich at a meeting of his Town Council, the whole of the Government's interest in the port of Richborough have been acquired by Messrs. Pearson and Dorman, Long. This combination of two well-known firms has for some time past been deeply interested in the exploitation of Kentish minerals, and it is presumed that the intention is to use Richborough as the centre of the county's coal and iron industries. The port was created by the Government during the war to facilitate the dispatch of munitions to the front, and at the end of 1917 a train ferry service was established between it and Calais and Dunkirk. At one time during the construction of the port as many as 20,000 men were employed. The work involved the reclamation of an extensive region of swampy foreshore, the widening and deepening of a natural waterway, the construction of a wharf and jetty nearly a mile in length, and the laying down of about 50 miles of sidings. Since the Armistice several abortive attempts have been made to dispose of the port to private ownership.

Cast Iron.

AT a recent meeting of the Institute of British Foundrymen, Mr. J. G. Pearce, director of research of the British Cast Iron Research Association, delivered a lecture on "The Future Improvement of Cast Iron." The lecturer explained that cast iron was not sufficiently uniform in quality and not homogenous enough for the engineer, and it was necessary that it should be studied with a view to discovering more about it, so that it could be used up to its limits so far as cheapness and inherent qualities would permit. Future improvement would be brought about partly by continued education, development and experience of the people in the industry, and partly by scientific research. The work had to be done co-operatively, and the British Cast Iron Research Association provided the best method whereby co-operative research could be undertaken. He believed that with the aid of the Association the industry would eventually take its proper place in the engineering world.

Leeds University.

IN celebration of the fiftieth anniversary of the founding of the Yorkshire College of Science and of the twenty-first anniversary of the raising of that College into the University of Leeds, a large gathering of academical and other authorities has been taking part this week in a series of functions at Leeds. On Monday Sir Dugald Clerk recalled the fact that fifty years ago he was a member of the staff of the Yorkshire College, which staff then numbered six, as compared with the University's 300 to-day. The Earl of Balfour referred to the founders of the College, Lord Cavendish, Mr. W. E. Forster, Lord Playfair, and Sir Arthur Rucker, and said that they had at first been dominated by the idea of providing technical education; that was to say, practical knowledge leading to an amelioration in the material welfare of mankind. They soon realised, however, that on such a basis they could never create a university, and that it was essential to cultivate the speculative side of natural knowledge. Applied science, he added, was impossible without pure science, and pure science could only properly be studied by those who sought in the main the augmentation of knowledge for its own sake.

The Motor Liner Aorangi.

DURING the last ten days the new motor liner Aorangi has undergone her preliminary and official trials with conspicuous success. She is a quadruple screw 600ft. mail and passenger ship of 17,500 tons gross, propelled by Fairfield-Sulzer six-cylinder two-cycle engines, designed to develop 13,000 brake horse-power, and is the largest motor liner yet built. On Tuesday last a very large company of shipowners and marine engineers accepted the invitation of the Fairfield Shipbuilding and Engineering Company, Limited, to inspect the ship, and a very enjoyable demonstration run in the Firth of Clyde was made. The trials which have been made included an endurance test of over sixty hours' duration, during which time the speed of the ship was fully 18 knots, and there was a noticeable absence of vibration. Over 1600 nautical miles were covered during the tests. An outstanding feature of Tuesday's trip was the smooth running of the machinery. The owners of the Aorangi, the Union Steamship Company of New Zealand, are to be congratulated on the possession of such a fine vessel. The Aorangi is scheduled to sail from Southampton to British Columbia on January 2nd. On her arrival at Vancouver she will take up the company's service from that port *viâ* the Fiji Islands and Honolulu to Auckland, New Zealand, and Sydney, New South Wales.

The Early History of the Cylinder Boring Machine.*

By E. A. FORWARD, A.R.C.S., M.I. Mech. E.

A COMPLETE history of machine tools has yet to be written, although the development of certain tools, such as the lathe, has come under the notice of the engineering historian. One machine of importance, which has hitherto received scant attention, is the cylinder boring machine, which is not only notable as being the first large machine tool in which the copying principle was carried out, but also because of the part it played in contributing to the development of the steam engine.

The earliest form of boring machine was merely a development of the hand worked auger—as illustrated by Agricola and other writers—used for boring wooden water pipes or pump trees, the auger being driven by a horse gear or water wheel, while the tree was mounted on a wheeled truck which could be drawn towards the auger by a rope and hand winch. When brass and iron pumps and also guns were introduced, the same mechanism was used, but the auger was replaced by boring bitts suitable for the metals to be operated upon. As the holes required were comparatively small, simple D bitts were probably the cutters generally used. It is obvious that with such machines a perfectly straight bore could not be expected even though the hole was truly circular at any one point.

With the advent of the Newcomen atmospheric engine, in 1712, larger cylinders were required, and it appears that at first these were unbored, but were simply smoothed inside by grinding or filing. Weighted soft packing and a water seal were relied on to keep the pistons sufficiently air-tight, but the rapid wear and consequent leakage probably soon led to attempts being made to bore the cylinders with the same machines as had been used for the smaller articles. This, however, involved the use of a boring head as large as the cylinder and having one or more cutters set round its periphery. Such a heavy head, mounted on the end of a comparatively small bar, necessarily tended to cut mainly on the lower part of the cylinder, while possibly barely touching the upper part; and as it depended for its guidance solely on the cylinder casting itself, the resulting bore was usually neither circular nor straight. To ensure cleaning up the whole interior surface, it became the practice to bore a cylinder in four settings, turning it through 90 deg. at each setting, but the result was no more accurate.

Perhaps the best recorded example of such a cylinder boring mill is the one erected by John Smeaton at Carron Ironworks in 1769, and which is described and illustrated in one of his "Reports." The imperfections of this machine were recognised, and Smeaton himself, when asked to improve it, could only suggest supporting the outer end of the boring bar on a four-wheeled carriage which travelled along the bottom of the cylinder; this, while taking the weight of the boring head, could not much improve the straightness or circularity of the bore.

The next and greatest step towards an accurate boring machine is attributed to John Wilkinson, of Bersham Ironworks, in or about 1775. His invention consisted in mounting a long stiff cylindrical bar in bearings at each end, and fitting it with a cutter head which could be traversed along the bar from end to end. This method gave at once a truly circular and straight bore, and it may be said that its invention removed from Watt's path what was perhaps the greatest obstacle he encountered in his endeavours to make his first steam engine a success, namely, the difficulty in obtaining a cylinder bored with sufficient truth.

When Watt removed from Glasgow to Birmingham in May, 1774, he brought with him his imperfect cylinder of hammered tin, which was found useless and abandoned early in 1775. By April of that year he had obtained a new cast iron cylinder, presumably bored on Wilkinson's new machine, and this proved satisfactory. Watt, writing to Smeaton in April, 1776, said, "Mr. Wilkinson has improved the art of boring cylinders so that I promise upon a 72in. cylinder being not further from absolute truth than the thickness of a thin sixpence in the worst part." Boulton also, writing to Carron Ironworks in the same year, said, "Mr. Wilkinson has bored us several cylinders almost without error, that of 50in. diameter, which we put up at Tipton, does not err the thickness of an old shilling at any part, so that you must either improve your method of boring or we must furnish the cylinder to you."

Wilkinson did not take out a patent for his cylinder boring machine, although his gun boring patent of 1774 is sometimes confused with it. Rival iron-founders, recognising its value, soon copied it, and from the Boulton and Watt correspondence we learn that, in May, 1780, a boring mill on Wilkinson's plan was being put up at Coalbrookdale. In the following year Wilkinson complained to Boulton that his mill had been copied by Banks and Onions of Benthall, and Watt, writing to Boulton on July 23rd, 1781, said, "As to Wilkinson's complaint of Onion's boreing mill, he ought to have taken a patent or kept it secret." In August, 1781, one of Boulton and Watt's erectors at Ketley was asked to inquire if Onions's boring mill was at work, and later in the same month it is intimated that this mill was nearly completed.

In a letter of January 9th, 1782, Watt tells Boulton that "Hornblowers are erecting a Wilkinsonian boreing mill for their cylinders." In 1792 the Eagle Foundry at Birmingham put in a mill.

It has been suggested that Wilkinson's patent No. 1863, of 1774, for a new method of boring guns, although very clearly specified, could have been stretched to cover the cylinder boring machine, which was quite different in principle.

The fact that this patent was revoked in 1779, and that it was not until 1780 that the Coalbrookdale mill was erected, might suggest that Wilkinson's rivals did not risk copying his machine while that patent was in force. On the other hand, Watt's letter of 1781, already quoted, shows that Wilkinson's invention of the cylinder boring machine could and might have been patented.

Gregory's Mechanics, published in 1806, attributes the improved machine to Wilkinson, and describes its chief feature, but nothing appeared to be known of the details of it until recently, when the occurrence of the Watt Centenary, in 1919, led to the discovery, amongst the early Watt drawings at Birmingham, of two drawings of boring machines of great interest. Copies of these drawings are now in the Science Museum, South Kensington.

The more valuable of the two is a drawing entitled "Drawing of the Bersham Boreing Mill by Jn°. Gilpin"; it is undated but must have been made prior to 1795, as the Bersham works were closed in that year. It seems probable that the drawing was obtained by Boulton and Watt as a basis upon which to design a boring machine for the new Soho Foundry in course of erection in 1795, or it may have been brought back some years earlier by James Watt or his son after one of their visits to Bersham. It is not known who Jn°. Gilpin was, but a Gilbert Gilpin was Wilkinson's clerk or manager at Broseley up to 1786, so that John Gilpin may have been a relative of the latter.

The drawing is to a scale of 1 : 36 and is coloured; a copy of it is shown in Fig. 1. It will be seen that the general lay-out is similar to the Smeaton type of mill in that a water-wheel drives, through spur gearing, two parallel horizontal axes on each side of it. In fact, the mill has the appearance of being a modification of an earlier one, as there exist on it a travelling carriage and hauling winch such as were used for mounting the cylinders on those mills. The mill has two boring bars, a large one 12in. diameter and 15ft. long, and a smaller one opposite to it 10in. diameter and 14ft. long; each is shown with a cylinder fixed in position by chains, the larger one being 45in. diameter by 11.25ft. long, and the smaller one 27in. diameter by 6.75ft. long. The remarkable point about these bars is that they are hollow, a feature which had been hitherto, but erroneously, attributed to Wm. Murdock, and the cutter heads are moved by central rack bars which pass down inside the boring bars, where they are connected with the heads through slots running the whole length of the bars. The racks are prevented from rotating by guided cross-heads at their outer ends, and the feed motion is given by weighted levers on the axes of pinions engaging with the racks, that being the common method of feeding the tools in the cannon boring mills of the period. Adjacent to the larger bar is what appears to be a facing lathe with a large hollow mandrel and a back centre; this may have been used for turning cylinder covers, pistons or boring heads. Opposite to this is a lathe with a long wooden bed and loose headstock, apparently for turning such objects as piston-rods or even the boring bars, but no tool-rest is shown. Incidentally it should also be noted that the gearing on one side of the water-wheel has stepped teeth.

The chief constructive feature of the boring machine, after having established the Wilkinson principle of guiding the cutter head along a straight bar, is the method of feeding the head, and the development of this has been somewhat obscure. This Bersham drawing establishes the fact that Wilkinson's bars originally had the rack feed, and it will be interesting subsequently to try and trace the introduction of the screw and positive feed as ultimately adopted. Not only does the drawing show the construction of Wilkinson's machines, but it lends support to the tradition that an old boring bar now in the Science Museum, South Kensington, is, in fact, an original Bersham bar.

The bar in question is 15ft. long and 11.875in. diameter, and was presented to the Museum in 1913 by the Hydraulic Engineering Company, of Chester, through the instrumentality of the late Mr. E. B. Ellington. With it came the following statement as to its history, made in 1878 by Mr. Ellington's partner, Mr. Bryan Johnson:—"An iron foundry at Bersham, near Wrexham, carried on, I believe, by Mr. Wilkinson, was at that time capable of making the largest castings then asked for. Messrs. Boulton and Watt used to get the cylinders for their earlier pumping engines made at Bersham, and the boring bar in question was made there and employed in boring these cylinders. When the Foundry was given up, the bar was purchased by Messrs. Rigby, Engineers of Hawarden and Sandycroft. By them the bar was turned up again and fitted with a new screw, the original boring head being bushed. Mr. Howell, Messrs. Rigby's manager, who gave me these particulars, said that on turning the bar the metal was found to be of very first class quality, the cuttings being quite like wrought iron. When Messrs. Rigby gave up business, about the year 1854, I purchased the bar at the sale of their plant."

The dimensions of this bar—Fig. 2—agree very closely with those of the large bar shown on the Bersham drawing, but it is now fitted with a screw operated by spur gearing which rotates it at a slightly lower speed than the bar. When the screw feed was first fitted to this bar is not exactly known, but

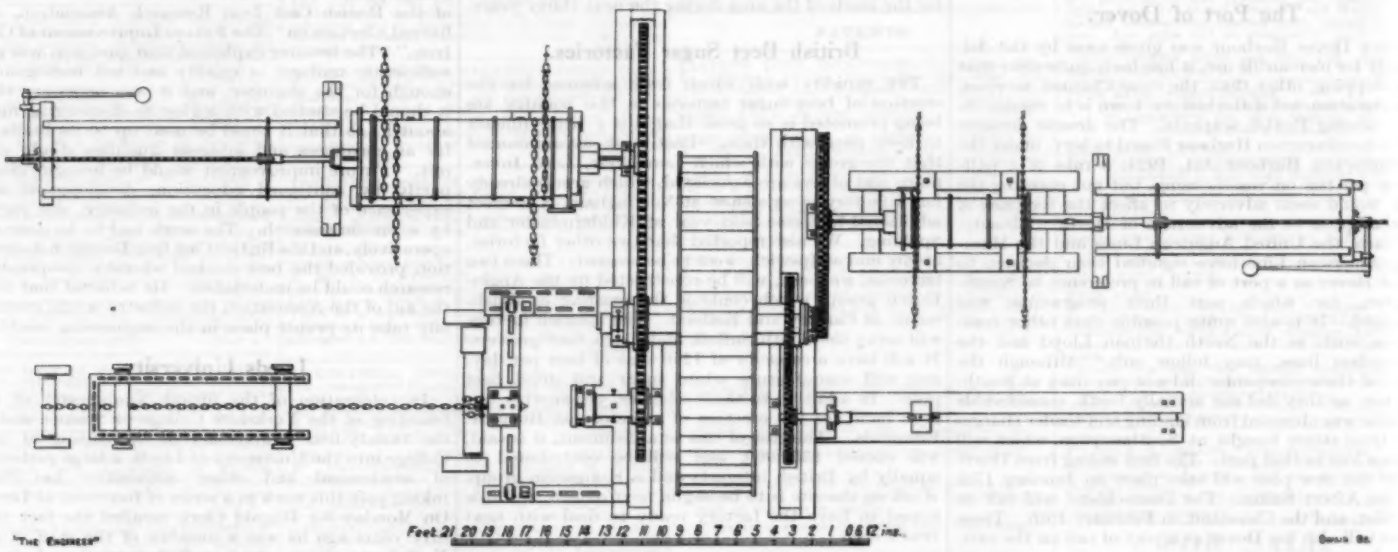


FIG. 1—BERSHAM BORING MILL, 1775

* The Newcomen Society. Read Wednesday, Dec. 17th, 1924.

as the Bersham works closed down in September, 1795, Messrs. Rigby must have acquired it at that time. Mr. Johnson's statement that it was turned up and a new screw fitted by Messrs. Rigby seems to imply that the new screw replaced an older one; if that were so, it would mean that the old screw was fitted at Bersham, and had been in use long enough to become worn out. In that case, it is to be expected that the screw feed would have been known to other makers before 1795, which does not appear to have been the case, as we shall see later. It seems, therefore, more probable that Mr. Johnson meant by his statement that the first screw was fitted by Messrs. Rigby after the bar was acquired by them.

This bar is now arranged for driving by a large

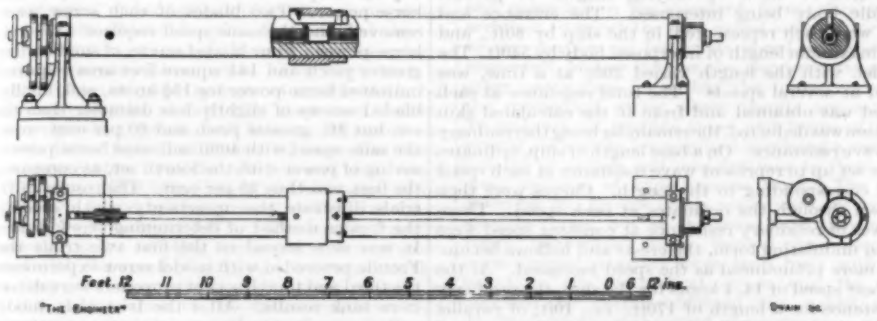


FIG. 2—BERSHAM BORING BAR IN THE SCIENCE MUSEUM

carrier keyed on one end of the bar, but beyond this there appears to have been a square end, such as would have carried a spur wheel—as shown on the Bersham drawing. This, however, has been cut off and the end of the bar bored to receive the tail of the screw. The other end of the bar originally terminated about an inch beyond the bearing, and the bore, which is 4in. diameter, was carried through to the end. An extension piece has been fitted to this end to provide a bearing for the feed screw and space for mounting the spur wheel which rotates it. A 2in. diameter hole passes transversely through the bar at the point where the slot is enlarged for the insertion of the nut. A hole, such as this, is not required for the nut, but was necessary for pinning the end of the rack bar, where it passed through the socket attached to the boring head. A brass bush, 0.25in. thick, was fitted to the boring head, or rather to the sleeve on which the cutter heads were mounted, and the nut, about 6in. long, is bolted to a large key, which fits the slot in the bar and engages with a groove in the sleeve. The key is secured by a screw and a cotter, the drive being taken by a head on the key. The bar is now mounted on two cast iron pedestal bearings, having lower brasses only, but these are probably more modern. The present screw is 2.5in. diameter, and has a right-hand square thread of two turns per inch. The gearing consists of a 60-tooth wheel on the end of the bar engaging a 63-tooth wheel revolving on a pin projecting from the pedestal. Fixed to the latter wheel is a 60-tooth wheel gearing with a 63-tooth wheel running loose on the plain end of the screw, and having dogs projecting from its outer face. This wheel can be connected with the screw by a sliding hand wheel keyed to the screw and provided with corresponding clutch dogs. For every turn of the bar the screw rotates about one-eleventh of a turn relatively backwards, giving a feed of 0.046in.

There is, then, a strong probability, if not certainty, that this bar, but not its feed screw, is one of the original Bersham bars used by Wilkinson for boring Watt's engine cylinders between the years 1775 and 1795.

When Boulton and Watt's Soho Foundry was under construction in 1795, naturally one of the most important tools required would be a cylinder boring machine, and it may be supposed that the Soho machine would be based on Wilkinson's. The question of its design had evidently been under consideration by Watt and Boulton, for on June 8th, 1795, James Watt, jun., writing to Boulton, says: "Inclosed you have Mr. Peter Ewart's plan for perpendicular boring, which I address to you as the advocate of that mode of operating. When you and my father have come to a decision upon the subject, I shall be glad to know it, that we may immediately be proceeding with the boring rod and other essential parts." Fortunately, the drawing mentioned in this letter has been preserved, and is the second of the two found in the Birmingham collection. It bears the date of the letter, written in the handwriting of James Watt, jun.; a copy of it is shown by Fig. 3. The description on the drawing is as follows:—"A. a shaft from the engine. The shaft B. is inclined that the wheel C. may be out of the way. The spur wheel D. to be wedged upon the rod E. F. a floor over the wheel. When a cylinder is to be put on, the sliding pieces G. must be put into such of the holes H. as are fittest for the length of the cylinder. The piece I. (having the spindle K. fixt upon it) must be removed and the cylinder lowered down till the top flanch rests upon the bearers L. The sliding pieces G. being then drawn out and the iron pins N. being put in, the cyl'r must be adjusted to the rod by the screws O. The bearers L. being fastened by the wedges P., the cyl'r is kept from turning round by the wedges Q. After the cylinder is bored, the top and bottom flanches may be turned by cutters fixed in the same tool by which the cylinder was bored."

The Ewart mill is a vertical one, as explained in J. Watt, jun.'s letter, but differs from Wilkinson's in that the boring bar is solid with a keyway along it, and that the feed is obtained by two external rack bars connected with a loose ring on the cutter head and operated by pinions. The means by which the pinions were to be turned is not shown. The bar is 12in. diameter and 14.5ft. long, and is shown boring a cylinder 28in. diameter by 7.25ft. long. The whole machine is contained in a masonry pit, and its frame-work is entirely of wood. It seems to have been actually constructed, because in a later letter J. Watt, jun., mentions the bar as having been made at Bersham. In 1895, when the Soho Foundry was dismantled, there existed several early horizontal screw-feed boring bars, and a large vertical mill, which was built much later, but by that time there was presumably no trace left of this pit mill, so that how long it remained in use is uncertain.

Neither Watt nor Murdock took out any patents for actual cylinder boring machines, but in 1802 we find that a certain Michael Billingsley, of Bowling Ironworks, near Bradford, patented a vertical boring machine which was practically an exact copy of Peter Ewart's machine, except that the framing was of iron instead of wood. The cutter head was moved by two external racks, as in Ewart's machine, but the pinions were rotated through gearing by a belt passing round the boring bar itself. Billingsley claimed the invention of the vertical arrangement, and also this form of positive automatic feed, stating that the latter is superior to the hand lever feed. This kind of feed motion may have been employed on Ewart's mill, as it would seem to be a natural improvement on the weighted lever feed. There is a suggestion of something of the kind in a letter from Watt to Boulton, dated May 16th, 1797, where he says: "Boring by means of the strap succeeds extremely well, to make matters complete will require however an expensive alteration." Of course, this statement might also be interpreted to refer to the substitution of a belt for the gearing used to drive the bar itself. There is no suggestion of the screw feed being in use at the date of Billingsley's patent.

William Murdock returned to Soho from Cornwall in 1798, and in 1799 he patented the worm and worm wheel method of driving boring mills. His specification drawing shows the driving end of a horizontal machine, but does not show the bar itself. He states the size of a worm that he had been using, which was 16in. diameter, three threads, 6in. pitch, and its bearings are shown mounted on masonry piers, as were those of a dismantled 16in. hollow bar, which lay at Soho in 1895, and was then said to be the first ever made there nearly 100 years ago, and credited to William Murdock. From this it is evident that Murdock had made a horizontal cylinder-boring machine at Soho in 1799, but we are unable to say with certainty that he introduced the screw feed at that time.

(To be continued.)

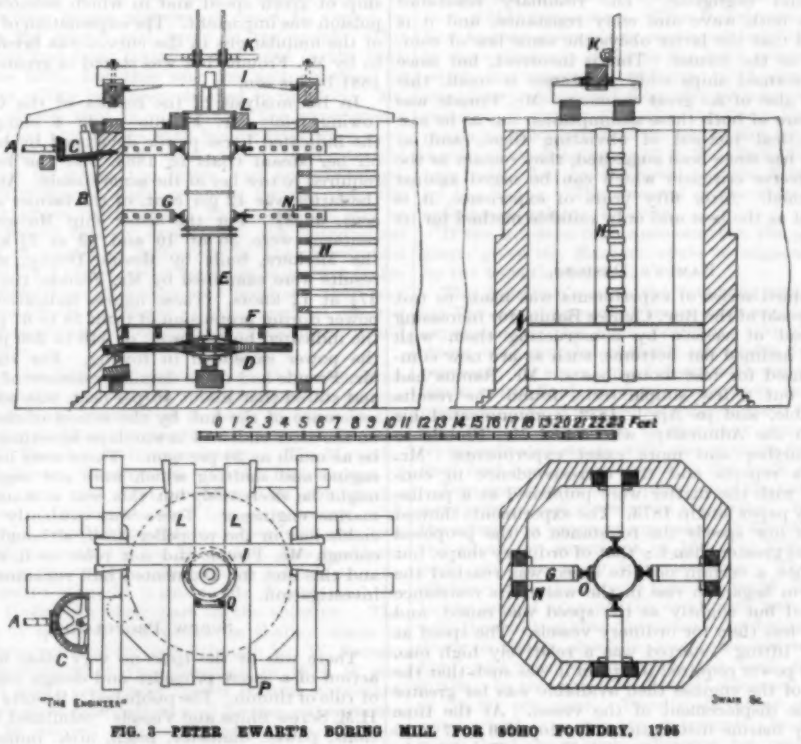


FIG. 3—PETER EWART'S BORING MILL FOR SOHO FOUNDRY, 1795

The Work of W. and R. E. Froude.

By A. W. JOHNS, C.B.E., R.C.N.C., M.I.N.A.

No. II.*

The Greyhound Trials.

The experiments on the Greyhound were intended to test the accuracy of the law of comparison, based on theoretical considerations by Mr. Froude, which, after the surface friction results were available, he admitted, applied only to wave making or residuary resistance. This vessel of 1160 tons and 10 knots speed, was towed by the Active of 3000 tons and 15 knots speed. Many precautions were taken to eliminate factors which might introduce uncertainties. The masts were taken out to obviate wind resistance; the tow rope was led from the end of a boom 45ft. long, standing out from the Active's side to prevent the Greyhound passing through water set in motion by the towing ship; speeds and forces were automatically recorded; and runs at each speed were made in opposite directions to allow for the effect of wind and tide. The speed of the ships was varied from 3 to 12.8 knots, and the results showed that the resistance up to 8 knots satisfied the speed squared law, but beyond that speed increased at a greater rate than the square, and, in fact, at the highest speed varied as the 4½th power. At 12.8 knots the resistance was 24,000 lb. instead of 14,400 lb., as it would have been if the speed squared relation had held—an explanation of some of the inconsistencies of the Admiralty coefficients. The wave system of the Greyhound was observed by Mr. Froude to be exactly similar to that of its model at the corresponding speed, a similarity which he also noted in the wave systems of the larger and small Ramus models.

A comparison of the results of total resistance of the Greyhound and its model, brought to the same scale by Froude's law of comparison, showed that the model results were in excess; but when from each the frictional resistance calculated from the results of the experiments already noticed had been deducted, the remainder or the residuary resistance curve of the model was below, but nearly parallel to that of the ship. In the calculations for frictional resistance, the coefficients determined for varnish had been used for both model and ship, but the bottom of the latter was coppered, the metal was not new, and it was reasonable to suppose that the coefficient was greater

* No. I. appeared December 12th.

than for a varnished surface. By increasing the coefficient slightly the two curves coincided throughout the range of speed. The law of comparison was completely confirmed, or, as Mr. Froude stated:—"The experiments in the ship when compared with those in the model substantially verify the law of comparison which has been propounded by me as governing the relations between the resistances of ships and models." In the discussion which followed the reading of the paper describing the foregoing results, Scott-Russell stated that thirty years previously he had made experiments with ships and models, although apparently he had no idea as to the true relations between the results, and made no allowances for the differences in skin friction resistance which Mr. Froude had now shown to be so necessary to secure correct comparison. The Admiralty authorities accepted the results of the Greyhound's trials as a complete confirmation of Mr. Froude's law of comparison, and model experiments for new warships became an ordinary and necessary part of their design. At the same time the publication of the values of the Admiralty coefficients and other information obtained on the trials of H.M. ships was discontinued.

Froude's Method.

The method adopted by Mr. Froude may be briefly referred to. A model in paraffin wax of the ship, about 12ft. to 18ft. long, is constructed, and its curve of resistance obtained by towing it at various speeds in the tank. The wetted surface of the model is estimated, and with the data of the skin friction experiments a curve of model frictional resistance is obtained by calculation. The difference between the total and skin friction resistances at any speed is the residuary resistance at that speed. A curve of model residuary resistance is thus obtained, and from it that of the ship at corresponding speeds is easily derived by the law of comparison. The skin friction resistance of the ship is next calculated, and if at any speed this is added to the residuary ship resistance, the sum is the total resistance of the ship at that speed. In the calculations for skin resistance of model and ship, the assumption is made that it is equal to that of a parallel plank of the same wetted area and length as those of the model and ship respectively. The curved surface and varying girth of model and ship render this a doubtful assumption, and the skin friction resistance probably too small, thus magnifying the residuary resistance of both. In ordinary ships the effect on the total resistance is small and negligible. The residuary resistance includes both wave and eddy resistance, and it is assumed that the latter obeys the same law of comparison as the former. This is incorrect, but since in well-formed ships eddy resistance is small, this error is also of no great moment. Mr. Froude was well aware of both these assumptions, but as he saw no practical method of obviating them, and as nothing has since been suggested, they remain as the only adverse criticism which can be urged against his method. After fifty years of experience, it is accepted as the best and only suitable method for its purpose.

Ramus's Designs.

The third series of experiments was made to test the proposal of the Rev. Charles Ramus for increasing the speed of vessels by constructing them with stepped inclined flat bottoms, such as are now commonly used for fast motor boats. Mr. Ramus had carried out a few simple tests, found the results favourable, and in April, 1872, communicated his ideas to the Admiralty, who asked Mr. Froude to make further and more exact experiments. Mr. Froude's reports and the correspondence in connection with the matter were published as a parliamentary paper late in 1873. The experiments showed that for low speeds the resistance of the proposed form was greater than for that of ordinary shape, but that when a certain definite speed was reached the new form began to rise in the water, its resistance increased but slightly as the speed was raised, and was far less than for ordinary vessels. The speed at which "lifting" started was a relatively high one, and the power required to attain it was such that the weight of the engines then available was far greater than the displacement of the vessel. At the time ordinary marine installations developed 6 to 7 indicated horse-power per ton, but Messrs. Thornycroft, in the Miranda, had succeeded in installing engines and boilers developing about 36 indicated horse-power per ton. They were, however, far too heavy for the purpose, and it was not until the development of the petrol engine, giving 100 to 200 brake horse-power per ton, that the proposal became a practicable one. This was from twenty-five to thirty years after the Rev. Charles Ramus had mooted the idea. Mr. Froude's experiments and reports are interesting as being the first and most complete on the resistance of this novel form of vessel. He used a large and small model, and his experiments incidentally confirmed the correctness of his law of comparison, and the similitude of the wave systems of similar models at corresponding speeds.

Wave-making Resistance.

Another very important investigation made by Mr. Froude was that relating to the influence of the length of a ship on the wave-making resistance. It had previously been held that this depended only upon the lengths of entrance and run—the fined portions of the ship forward and aft—and was independent of the length of the parallel middle body or of the whole length. In 1876 Mr. Froude had described some experiments with four models, all of the same displacement, and with similar runs forward and aft. In two, the runs extended to amidships, but in the others there were lengths of parallel middle body. The two former had much less resistance than the others for speeds at which wave resistance was important. In 1877 at the Institution of Naval Architects Mr. Froude gave an account of his more extended experiments on the same matter with a model with identical entrance and run, but arranged to allow of varying lengths of parallel middle body being interposed. The entrance and run were each represented in the ship by 80ft., and the maximum length of interposed body by 340ft. The model, with the length varied 20ft. at a time, was tried at several speeds. The total resistance at each speed was obtained and from it the calculated skin friction was deducted, the remainder being the residuary or wave resistance. On a base length of ship, ordinates were set up to represent wave resistance at each speed and corresponding to the length. Curves were then drawn through the ordinates at each speed. These curves of residuary resistance at constant speed were of an undulating form, the crests and hollows becoming more pronounced as the speed increased. At the highest speed of 14.4 knots for the ship, the residuary resistance for a length of 170ft., *i.e.*, 10ft. of parallel middle body, was 7.2 tons, which gradually increased to 16.2 for a length of 220ft. An additional 50ft. of middle body reduced the resistance to 8.3 tons, which increased to 13.0 for an additional 60ft., decreasing again to 9.7 tons for a total length of 390ft., and rising to 11.8 for 440ft. At about 11¼ knots the residuary resistance was practically the same for all lengths, and equal to 2 tons. For intermediate speeds the distances between hollows and crests were less than at 14.4 knots.

The results showed very clearly the residuary resistance at a given speed, for which its proportion to the total resistance was relatively high, depended to a very great extent upon the length of the ship, and that by choosing a length which corresponded to a hollow on the resistance curve at that speed an appreciably smaller wave resistance was experienced than if the length fell on a crest. Here, then, was a point well worthy of consideration in the design of a ship of given speed and in which economy of propulsion was important. The explanation of the causes of the undulations in the curves was briefly referred to by Mr. Froude, but was stated in greater detail in 1881 by his son.

In his analysis of the results of the Greyhound towing trials Mr. Froude made a comparison of the indicated horse-power developed by her engines on her steam trials in 1865, and the horse-power required to tow her at the same speeds. At 10¼ knots the latter was 42 per cent. of the former and 35 per cent. at 8¼. For the sister ship Mutine the percentages were 36 at 10 and 33 at 7½ knots. For the Merkara, built by Messrs. Denny, whose trial results were examined by Mr. Froude, the value was 37½ at 12 knots. These figures indicated a loss of power during propulsion of from 58 to 67 per cent. of the indicated horse-power, or 140 to 200 per cent. of the power expended in towing. For the Merkara Mr. Froude had made detailed estimate of the losses, and stated that about 40 per cent. was added to the resistance of the hull by the action of the propeller on the after end, and in warships he estimated this to be as much as 50 per cent. There were losses in the engine and shafting which were not negligible and might be decreased, but this was a matter for the marine engineers. There was evidently an appreciable loss in the propeller itself, although curiously enough Mr. Froude did not refer to it specifically, and this and the augmented hull resistance required investigation.

Screw Propulsion.

There was at the time no very clear idea on the action of a screw propeller and design was a matter of rule of thumb. The published "Results of Trials of H.M. Screw Ships and Vessels" tabulated the revolutions, power, diameter, pitch, area, immersion, and slip of the propellers for all trials, and also the ratios of pitch to diameter and disc area to immersed midship area. From these figures the approximate dimensions and area of propellers could be determined when the horse-power, revolutions and speed for a new design were known. But, as with the Admiralty coefficients for power, the choice of values from the many trial results was a very wide one, and if by their use a good screw was secured it was wholly a matter of speculation.

In 1865 Professor Rankine, at the Institution of Naval Architects, propounded his theory of screw propulsion based on the momentum principle, and obtained an expression for the efficiency in terms of the slip. The latter was, however, an uncertain quantity, since the wake velocity was unknown and could only be determined by experiment. Although of great academic interest, the theory was of little practical use. The B.A. Committee of 1868, already referred to, dealing with screw propulsion, remarked, "theoretical investigations have been extended in advance of the point at which fresh experimental foundations ought to be laid for them," and this opinion must have been shared by all those who were engaged in design work.

In 1878 two important papers were read at the meetings of the Institution of Naval Architects, the first by Mr. W. H. White compared the results of some recent trials of ships fitted with twin and single screws, and the second, by Mr. Froude, explained his theory of screw propellers. The former paper included results of the earlier trials of the Iris, a twin-screw vessel, in which various sets of screws were eventually fitted with very different results. The first propellers tried were four-bladed 18½ft. diameter, 18½ft. pitch and 194 square feet area, and on trial 15¾ knots speed was obtained with 6200 indicated horse-power. Two blades of each screw were then removed, and the same speed required 4370 indicated horse-power. Four-bladed screws of smaller diameter, greater pitch and 144 square feet area required 4100 indicated horse-power for 15¾ knots, and, finally, two-bladed screws of slightly less diameter than the first set, but 3ft. greater pitch and 60 per cent. area, gave the same speed with 4000 indicated horse-power. The saving of power with the fourth set, as compared with the first, was thus 55 per cent. The results of the first trials illustrate the uncertainty which accompanied the former method of determining screw dimensions. It was as a sequal to the first two trials that Mr. Froude proceeded with model screw experiments, and the third and fourth sets of propellers were determined from tank results. After the Iris trials, model propeller experiments became a routine matter for all warship designs.

Mr. Froude, in propounding his theory, considered an annular element of the blade area, obtained its velocity both in amount and direction relatively to the water supposed at rest, and calculated the normal and tangential forces acting on it by using coefficients which he had determined by his experiments on plane surfaces. He then resolved these forces longitudinally to obtain the thrust, and transversely for the force resisting turning. Expressions were thus obtained for the useful work, for the turning moment and for the efficiency of the screw. By mathematical treatment, he obtained the conditions for maximum efficiency and the corresponding thrust and turning moment on the element. The first he found to be 77 per cent., a value not differing greatly from that found later by experiment. He indicated that by integration over the blade area similar expressions might be obtained for the whole screw. A criticism which has been levelled against this method is that, although the coefficients for friction and normal pressure may be correct for an isolated element moving in a straight line, it is doubtful if they are strictly applicable when movement is in a spiral path as in a propeller, and the element forms a small portion of a larger area. The interference of other blades is also a factor which must be taken into account, especially with the very broad blades adopted in some high-speed ships. The theory, however, is the simplest and least complicated of many which have been advanced, and has been used for the determination of aeroplane propellers, where, with relatively narrow blades, interference is small. In this latter application the normal and tangential forces employed by Mr. Froude have been replaced by those of lift and drag, the data of the aerodynamical laboratories being presented in this form. In the case of aeroplane propellers, the problem is simpler than for ships, since "wake" is absent. This cannot be calculated, and can only be determined by experiment, and hence all theories of propeller action are of little value unless supplemented by trials on models or ships. Although Mr. Froude's paper on propellers was read in 1878, propeller experiments were first made at Torquay in August, 1873, and were followed by those behind a model of the Encounter in October of the same year. These earlier experiments were, however, principally concerned with the augmented resistance of the hull due to the screw. The results of the Iris trials showed the importance of propeller design and of more experimental investigation on the factors affecting screw efficiency.

The paper on propeller action was the last of many read by Mr. W. Froude at the Institution of Naval Architects. He was at the time a member of the Committee of Designs inquiring into the stability of the Inflexible, which had been seriously questioned by Sir E. Reed. This work kept him engaged during 1878, and in December he started on a voyage to the Cape for the benefit of his health, was attacked by dysentery, and died in May, 1879.

The extension and development of W. Froude's work on ship resistance and on propeller phenomena were left to his son, Mr. R. E. Froude, who for some time previously had been assisting him in the experimental work at Torquay. Born in 1846, Mr. R. E. Froude had, as already mentioned, been trained as a civil engineer, but indifferent health had prevented him from practising his profession, and necessitated a stay in the South of France before he became assistant to his father. On taking charge of the work, he was appointed by the Admiralty Superintendent of the tank, and continued at Torquay until 1886, when the whole establishment was transferred to Haslar, opposite Portsmouth, where a larger and more substantial tank had been built by the Admiralty. He

continued there until 1919, when he retired. He was not such an expert mathematician as his father, and at times acknowledged he found his incomplete knowledge a disability in his work. He possessed, however, a curious and useful faculty for developing an argument or theory by starting from first principles, and obtaining results which the trained mathematician would have secured by shorter and quicker methods. Possibly, for this reason, he was not such a rapid thinker as his father, and his papers are not so clear and his arguments more laboured than those of Mr. W. Froude, which in this respect are admirable.

WAVE RESISTANCE.

Mr. R. E. Froude's first paper at the Institution of Naval Architects in 1881 was a review, explanation and extension of his father's of 1877 on wave resistance and the effect of length. He described the two types of wave systems—transverse and diverging—which accompany the motion of a ship, and by sketches of actual wave systems of similar ships, but of different lengths, showed that they were identical at corresponding speeds, and how, as the speed was altered, there was interference between the transverse wave system formed at the bow and that formed at the stern. This interference was the cause of the undulations in the residuary resistance curves shown by Mr. W. Froude in 1878. The length between successive crests of the transverse wave systems varied with the speed of ship, and was equal to that of a deep sea wave moving at the same velocity as the ship. If a crest of the transverse bow wave system corresponded in position with the first crest of the stern system, a maximum or crest was shown on the residuary resistance curve for the length of ship corresponding, whilst if a trough of the bow wave coincided in position with a crest of the stern system, a minimum or hollow on the residuary resistance curve was obtained. The speed of 14.4 knots of the 1878 paper corresponded to a length of deep sea wave of about 115ft., and the successive maxima or minima for this speed were approximately this distance apart. The first minimum was obtained for 170ft. length of ship, which was practically a wave length and a half, when the second trough of the bow wave was coincident in position with the first crest of the stern wave, whilst the first maximum was for a length of ship of 220ft., just two wave lengths, and resulting in the third crest of the bow wave coinciding in position with the crest of the stern wave. For smaller speeds the wave lengths were less, and the crests and hollows of the waves, and also of the residuary resistance curves, closer. Speed, length of ship and residuary resistance were thus shown to be closely interrelated, and a careful choice of length was required to secure minimum resistance at the highest speed. Besides dealing with the matter by the use of experimental results, he explained and confirmed these results by mathematical analysis. He showed also how the energy of a wave system moved forward at only one-half the velocity of the individual waves, and to compensate for this lag the ship's engines had to supply the requisite energy, and this was the principal reason for the residuary or wave resistance. He next remarked on the features of a ship which led to wave making, and recommended certain shapes of sections forward and aft which would give the best results so far as this type of resistance was concerned. Finally, he showed experimental results which indicated that increased draught involved more pronounced hollows and crests in the resistance curve. The paper was a complete explanation of the wave resistance phenomena of ships.

SHIP RESISTANCE.

The problem of ship resistance was dealt with in three other papers presented to the Institution of Naval Architects by Mr. R. E. Froude in 1888, 1892 and 1904. The two former explained the notation adopted at the Experiment Works as a standard for analysing and expressing the results obtained from ship's models, and also for representing the dimensions and other particulars This notation was based on an extended experience which had shown it most convenient for comparison of speeds, resistance and powers of the various forms which had been subject to test. Briefly, the length or other dimensions and the wetted surface were expressed in terms of those of an exactly similar model of one cubic foot displacement. The model was further defined by the prismatic coefficients for both forward and after bodies and by the midship area coefficient. The speed constant was expressed in terms of that of the corresponding speed of the cubic foot displacement vessel, and the resistance or power constant in terms of $\frac{\text{E.H.P.}}{\Delta^{\frac{2}{3}} V^3}$, the inverse of the old Admiralty displacement coefficient, with I.H.P. replaced by E.H.P. The element of absolute size is thus removed and comparison of forms thereby rendered easy and immediate. With such a system, and with results carefully recorded and tabulated for many models, it is not difficult for a naval architect to ascertain the effective horse-power required to drive a ship of any displacement, length or form, at a given speed. Such a standard notation also facilitates the comparison of results obtained from other experimental establishments.

The paper of 1904 gave the resistance results over a range of speeds for a number of forms constituting what is known as a methodical series. One parent form was taken, and five others derived from it by gradual and successive alterations in length and fineness of bow and stern lines. These six modles were subjected to further modifications in form, the principal of which was in effect to increase the length by keeping the cross sections constant and increasing the distances between them. Six variations in each of the six forms were thus effected, and, in addition, each of the thirty-six forms was tested at two ratios of beam to draught, the sectional areas being kept constant. Seventy-two forms all differing slightly in various ways were thus obtained, and their resistance curves for a range of speeds drawn from the tank results. The data thus obtained and presented in the standard form allow a naval architect to select the best model suitable for a particular purpose so far as its speed and power are concerned, and so long as the requirements and the other particulars lie within the limits covered by the methodical series whose results are available. To embrace all possible types and forms of vessels, several such series are required involving a very large number of models and modifications to them, and a great amount of experimental work. The results given by Mr. Froude in his paper were naturally for warship forms, but at the same time they covered many mercantile ships. Several very successful cross-channel steamers have been built with forms based on the methodical series, and the results obtained by them confirmed the model results. The method adopted served, moreover, as a valuable guide to other experiment tanks, such as those of private shipbuilders, who could experiment with series of forms differing from those adopted by Mr. Froude, and which would more nearly represent the forms of the merchant ships in which such firms might specialise.

In the following year Mr. Froude described some experiments with straight and hollowed lined cruiser forms which had been carried out as the result of a discussion which had taken place in connection with the "County Class" of armoured cruisers. It was stated their behaviour at sea was not all that could be desired, and it was considered that the defect was primarily due to their hollow lines forward. The model experiments were made under ordinary conditions of the tank, which represented calm water, and also in artificial waves created in the tank by a board operated by a crank at one end of the tank, which when in action sent along the tank a regular series of waves whose height and period could be varied by altering the length and speed of the crank. This apparatus had been installed and used in the tank for some time, but this was the first occasion on which its utility had been referred to publicly. Mr. Froude stated that in still water the experiments showed that the models with hollow lines were more economically propelled than those with straight lines, but in waves the latter had an advantage, although it was so slight as to be far less than the disadvantage in calm water. In his opinion, and he had confirmed this by experiment, the longitudinal moment of inertia as influenced by the distribution of weights in a vessel, was a far more important factor in the behaviour of a ship in a head sea than any difference which the shape of the vessel, as effected by the straightness or hollowness of the lines, would give rise to.

Before leaving the problem of ship resistance it is necessary to remark that progress in marine engineering has resulted in a large increase in the speeds of vessels as compared with those at the time of Mr. W. Froude's early experiments. The Miranda, built by Messrs. Thornycroft in 1872, had a speed of 15 knots, and was then considered an abnormally fast vessel. During the last few years many relatively small vessels have attained speeds of over two and a-half times that of the Miranda. New problems have arisen, have been successfully solved, and no small amount of credit is due to Mr. Froude and the staff at Haslar for their part in the solution. The problem of speed of fast vessels in shallow water is one of those referred to, and although Mr. W. Froude had experimented in this direction in 1874, it was not until many years later that it became important and of practical application, and further experiments had to be carried out to determine the effect of shallow water on speed.

Standards of Comparison for Steam Engines.

ON Thursday evening of last week the Joint Committee on Tabulating the Results of Heat Engine and Boiler Trials held a meeting at the house of the Institution of Civil Engineers in London to discuss a suggested improved standard of comparison for the thermal efficiency of steam engines. It will be recalled that in April of this year the Committee held a similar meeting at which standards of comparison for the thermal efficiency of internal combustion engines were discussed. On that occasion the discussion was based on a short paper submitted by Mr. G. J. Wells, of the East London College. Last Thursday the discussion was similarly opened by a brief statement presented by Captain H. Riall Sankey.

In his introductory note Captain Sankey recalled the fact that a Committee appointed in 1896 by the Institution of Civil Engineers recommended the adoption of the Rankine cycle as a basis for the comparison of the realised thermal efficiency in steam engines. Since that date, however, the quest for economy has resulted in the development of practices in steam engineering—specifically the practices of "bleeding" steam from turbines for the purpose of feed heating and of re-heating the steam after partial expansion—which are such that the Rankine cycle can no longer be applied in the case of engines in which these practices are used. Re-heating the steam can be repeated once or oftener, and, moreover, it can be combined with feed heating by the "bleeding" process. The question therefore arises whether a standard of comparison can be defined that will cover all conditions and cases.

In his paper, Captain Sankey suggested that such a standard could be set up by a process of extending the definition of the Rankine cycle. We give below the definition of the Rankine cycle, with the addition proposed by Captain Sankey indicated in italics.

In the Rankine cycle the feed water is taken into the boiler at the exhaust temperature, and its temperature is gradually raised until it corresponds to that of saturated steam. Steam is then formed at constant pressure, and in the dry saturated state. If the steam is to be superheated, heat is added to it at constant pressure and increasing temperatures until the required superheat is attained. The steam is then admitted to the engine at constant pressure, doing external work equal to the absolute pressure multiplied by the volume of displacement up to the point of cut-off. Beyond that point expansion takes place adiabatically, doing work until *any desired pressure is reached when the steam is re-heated at constant pressure to any desired temperature, whence adiabatic expansion takes place. The re-heating process can be repeated as often as desired. Finally, the steam is expanded adiabatically until it reaches the temperature of saturation corresponding to the boiler pressure. From this point adiabatic expansion continues doing work until the pressure in the cylinder is equal to the back pressure against which the engine is working. Alternatively, the steam is expanded from the saturation temperature corresponding to the boiler pressure in such a way that a portion of the heat is transferred to the feed water, the amount so transferred at every temperature being equal to the increase in water-heat at that temperature. This transference of heat for feed heating purposes is continued until* the pressure in the cylinder is equal to the back pressure against which the engine is working. The steam is then completely exhausted from the cylinder at constant pressure, corresponding with the lower limit of temperature, the work done on the steam by the engine during exhaust being equal to the absolute back pressure multiplied by the total volume swept through by the piston. The removal of the steam from the cylinder completes the cycle.

If the words in italics are omitted, the above paragraph gives the Rankine cycle as originally defined by the 1896 Committee.

The definition covers the following main cases:—(*a*) The use of saturated steam with simple adiabatic expansion to the back pressure; (*b*) superheated steam with simple adiabatic expansion to the back pressure; (*c*) superheated steam with one or more re-heats, with final adiabatic expansion to the back pressure; (*d*) saturated or superheated steam with feed heating expansion to the back pressure; and (*e*) superheated steam with one or more re-heats and final feed heating expansion to the back pressure.

Two examples of the application of the new standard were worked out in detail in the paper. In the first, the admission pressure was taken at 250 lb. absolute, the admission superheat at 160 deg. Fah., and the back pressure at 0.5 lb. absolute. The thermal efficiency in this case was found to be 33.70 per cent. In the second example the conditions were the same, with the addition that the steam, after being expanded down to 100 lb. absolute, was re-heated to 100 deg. Fah., and then expanded to the back pressure of 0.5 lb. In this case the thermal efficiency was given as 33.90 per cent. Twenty-six other cases were summarised in a tabular statement. In this statement the Carnot cycle efficiency for each example was also given, and the ratio between it and the suggested new standard cycle efficiency. Certain of the examples given were re-calculated, using Marks and Davis' and Goodenough's tables instead of Callendar's tables. The greatest disparity revealed in the thermal efficiencies was about 0.7 per cent., from which it was concluded that "the thermal efficiency of the standard of comparison can be obtained with sufficient practical accuracy by the use of any of the three tables."

Following the presentation of his paper, Captain Sankey said that in a written communication Mr. Wingfield had objected that the proposed standard of comparison did not cover the cycle using isothermal expansion, followed by adiabatic expansion with or without final feed heating expansion. Captain Sankey contended that neither of these cycles was practical, and in any event that the definition could be extended to cover them if isothermal expansion were regarded as composed of an infinite number of re-

heating steps. He suggested that the new standard should still be called the Rankine cycle, and intimated that the Committee had decided to recommend the use of Callendar's steam tables as standard.

Mr. Clark remarked that Captain Sankey's definition had completely surmounted the difficulties involved in applying the Rankine cycle to cases in which feed heating by bleeding and re-heating were employed, and thought that it would be very difficult to improve upon the definition. Mr. Kearton, on the other hand, held that the definition was not satisfactory, and that it might result in errors as great as those given by the simple Rankine cycle. He gave figures to show that in one instance the true efficiency ratio was 75 per cent., and not 70 per cent. as the Sankey definition showed it to be. Mr. Parsons urged that it was essential to use steam tables which gave consistent results, however they were employed. The available heat could be obtained either by the P V method or the $\theta\,\varphi$ method. In a specific case he found that the Marks and Davis' tables gave the available heat as 169.32 B.Th.U. by the P V method and 165.0 by the $\theta\,\varphi$ method. The Callendar tables gave 165.2 by both methods. The Committee, he held, compared all feed-heating turbines on exactly the same basis, namely, that of complete feed heating, no matter how much or how little feed heating they actually did. Such a procedure was no more justified than would be insistence upon the re-heating always being carried to the original superheat temperature, or the vacuum being always taken at some fixed figure. He would suggest that the bleeding cycle should always be used as the standard of comparison, even although bleeding was not actually used.

Mr. Martin suggested that it was premature and inexpedient to stereotype any standard of comparison until more was known about the behaviour of steam when expanded below the saturation line. He also held that in the comparison of different makes of turbines the efficiency ratios might be most misleading as a test of merit unless the steam conditions, both at the stop valve and at the condenser were identical. Professor Baker, who followed Mr. Martin, said he could not agree with him as to the standardisation of a cycle of comparison being premature. Standards, he argued, were not made to last for ever, and it was reasonable to devise some means of dealing with re-heating and feed heating which were not covered by the old Rankine cycle. On the other hand, he supported Mr. Parsons in his view that the proposed standard was weak in that the turbine in which there was no bleeding for feed heating was judged on a more favourable basis than one from which steam was bled. The Committee ought to lay it down that the turbine should be bled, and therefore penalise that which was not bled. Mr. Robinson suggested that there was a possibility of combining in one standard of comparison the requirements for turbines with and without bleeding. To this end he advocated that the efficiency of all turbines should be calculated on the average adiabatic heat drop in the steam right throughout all the stages.

In the course of his reply to the discussion, Captain Sankey remarked that many years ago the British Association defined the ohm long before it was possible to measure it accurately. To-day the value of the ohm was known to within one part in about 10,000, but the definition still held. He argued therefore that the Committee was equally justified in suggesting a standard of comparison for steam engines, in spite of the fact that all the properties of steam, a knowledge of which was required for the evaluation of the standard, might not be known with accuracy.

British Wire-drawing and Wire-working Machinery.

No. XX.—CONCLUSION.*

A Large Wire Drawing Bench.

A very fine example of wire drawing bench, which the makers claim to be one of the largest made in this country, is illustrated by Fig. 155 and would most appropriately have been included in the fourth article of this series, but has only been completed within the last few weeks.

As will be seen from the engraving, the bench is equipped with eight blocks, all of which are 20in. in diameter. They are spaced at 5ft. centres and are each driven by machine-cut bevel gearing and a cone clutch lined with Ferodo. The first two blocks run at 55 revolutions per minute, the next four at 65 revolutions per minute, and the last two at 80 revolutions per minute. The bevel pinions are split so that they may be easily replaced in case of breakage, without it being necessary to take out the main shaft. The machine is driven by a 60 horse-power electric motor through a compressed paper pinion and machine-cut spur wheel. The pull-in gear, it will be noticed, is of the capstan type and is driven from the main shaft by worm gear and a clutch.

An unusual feature about this machine is the arrangement of the swifts on the bench itself. This scheme was specified by the purchasers and is said to work satisfactorily, but it does not seem to give a very fair lead for the wire from the swift to the die block. The overall length of the bench is approximately 48ft., and the makers, William Grice and Sons, Limited, of Fazeley-street, Birmingham, say that it was lined up so accurately that it could be pulled round by hand on the main driving spur wheel with all the clutches in gear.

* No. XIX. appeared December 12th.

Sixteen-hole Continuous Drawing Machine.

In the fifth article of this series reference was made to the preference of some wire drawers for belt rather than toothed gear for driving the spindles of continuous wire-drawing machines. Yet another alternative system is illustrated by Fig. 156, which is reproduced from a photograph not then available. It represents a machine made by G. Hattersley, Limited, of Keighley, and, as will be seen, all the driving is effected by chains, with the exception that the spindle

FIG. 155—EIGHT-BLOCK WIRE-DRAWING BENCH—WM. GRICE

for the block is driven by a rope. Each of the drawing spindles drives the succeeding one at an appropriately increased speed. The machine is also noteworthy through having the unusually large number of sixteen die blocks, so that a very great reduction in the section of the wire can be made at one pass. It is, of course, only intended for fine gauge wire.

Pneumatic Die Battering Machine.

Die-battering machines, it will be remembered, were described in the third article of this series. An entirely new form of die-battering machine which has just been completed by Alldays and Onions, Limited, of Small Heath, Birmingham, is illustrated by the drawings Figs. 157 and 158. In it the blows are delivered by a pneumatic hammer, while the die is manipulated mechanically, and the makers claim that the arrangement has the advantages that the

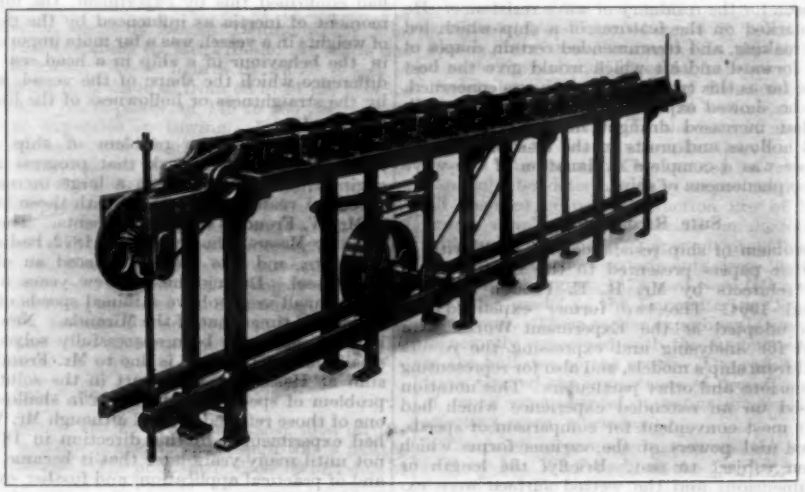


FIG. 156—CHAIN-DRIVEN CONTINUOUS WIRE-DRAWING MACHINE—G. HATTERSLEY

dies are battered evenly all over, the metal is drawn towards the centre of the die; the bearing therefore retains its length, and the dies are less distorted from their original shape. Three to four dies can be battered per minute, and under this process the life of the dies is said to be greatly increased. The machine is completely guarded, the working parts being enclosed, but the diagrams 1 and 2 of Fig. 158 are given to show the mechanism.

The blow is delivered at a fixed angle to the axis of the die to be operated upon, and at the same time the work holder rotates and traverses across the face of the hammer, which is arranged to give variable power blows. The hammer, it will be seen, is carried by a bracket supported from the pedestal of the machine, while the work is placed in a receiver, which is capable of revolving, and is carried on a slide operated by a cam. The slide moves in such a manner that blows are received upon the work on a path forming a slow spiral, until the last revolution, when the blow falls on a circle around the centre of the work. The blows of the hammer are automatically varied in force by the adjustment of the hammer valve by means of a rod, which is moved over an inclined plane as the slide traverses through its stroke.

After placing the die in the receiver of the revolving table B, the machine, which is belt driven through a single pulley and friction clutch, is set in motion by moving the lever F towards the centre of the machine. This action engages the clutch N with the pulley, and sets the rotary parts of the machine in motion. Simultaneously, through the lever Q and link R the main compressed air valve J is opened. The hammer immediately comes into contact with the work and starts to strike blows. When the machine is in motion the lever F is held in position by pressing down the control O, which, in turn, is held by the automatically operated trip plate M.

The rotary parts of the machine are driven through the pulley shaft, which, on the centre line of the machine, carries the worm U. This worm engages the worm wheel T, carried on the vertical shaft Y, upon which is mounted the cam D. This cam engages with the cam plate E to obtain the traverse motion of the slide A. The table B is revolved through bevel gears carried in the bracket H, the crown wheel being fixed at the opposite end to the pulley on the driving shaft, while the pinion is keyed to a vertical spline shaft, capable of sliding through the bevel sleeve gear revolving in the bracket G. The brackets H and G are capable of swivelling on the pulley shaft, and the horizontal shaft X, in order to maintain alignment as the cross slide travels through its stroke. The worm shaft X is driven by the bevel pinion in the bracket G, and is carried in bearings secured to the slide A. Between the bearings is mounted the worm V, which engages with the worm wheel of the revolving table B.

When the slide A is moving on the forward stroke, the rod L is held by a spring against the adjustable inclined plane K, and, as it goes forward, revolves the valve S of the hammer, and thus regulates the force of the blows on the die.

The diagram No. 1 shows the cam D approaching the end of its cycle, and No. 2 shows the position of the cam D and plate E when the machine has completed its cycle and is stationary for reloading. On the return of the slide, which is spring-loaded against the cam D the striker plate W strikes the trip plate M and releases the control O. This, in turn, liberates the main lever F, to fall into the "off" or "stop"

position. At the same time the main air valve J is closed, and the tup of the hammer rises away from the work.

CONCLUSION.

In conclusion of this series of articles, it should be pointed out that, throughout, attention has been concentrated on British made machinery, to the exclusion of foreign, although many ingenious wire-working machines have been developed abroad and have a certain vogue in this country, but it is obvious that if equally good plant of British manufacture is available, it must be our policy to advocate it rather than the foreign product.

Yet the British wire industry cannot afford to shut its eyes to the developments which are taking place in other countries, and it is noteworthy that strenuous efforts are being made, specially in America, to increase the speeds at which wire can be drawn. Thus the Western Electric Company, of New York, has recently been experimenting with a form of die, certainly not entirely novel, but which, it is claimed, permits wire to be drawn at speeds as high as 2500ft. a minute. Even this high speed is eclipsed by Messrs. L. and P. Bréguet, of Geneva, who claim to be able to draw wire at the rate of 100 kiloms. per hour, or, say, 5500ft. per minute. In neither case is the gauge of the wire disclosed, but it must be very fine, and it is possible that the time lost through breakages may counterbalance that saved by the increased speed.

In the drawing of heavy and medium gauge wire the British makers are pre-eminent, a fact which is, no doubt, largely to be accounted for by the long association of families with the industry and the consequent development of that faculty which is generally ascribed to heredity. It is noteworthy in this connection, that wire drawing is principally confined to a few circumscribed localities, such as Birmingham, Warrington and the Spen Valley of Yorkshire, with the result that the people of those places grow up under the influence of the industry.

In other directions, however, continental inventors have done much towards the development of the wire-working industry. Thus some of the French nail-making machines are really most ingenious, while the Germans have elaborated plant for making wire fencing to a high degree of excellence, and, with the English exception already mentioned, diamond dies are exclusively made on the Continent.

Complaint may be made that these articles have been brought to a conclusion without any reference to several important branches of the wire industry, among which may be mentioned the manufacture of wire ropes; but the machinery involved in that trade is so similar to that used in the electric cable business that there is no necessity to deal with it separately. Then, again, there is the intricate machine used for setting the "teeth" in the clothing used on textile carding engines. In this case, however, the reason for omission is the unwillingness of the owners—the business is in very few hands—to have their processes disclosed. There are hooks and eyes, staples, corset stiffeners, umbrella frames, chains and a hundred and one other items for the production of which special machinery has been evolved; but it would occupy a vast amount of space if they were all individually described, while most of them are merely modifications of the generic types already dealt with.

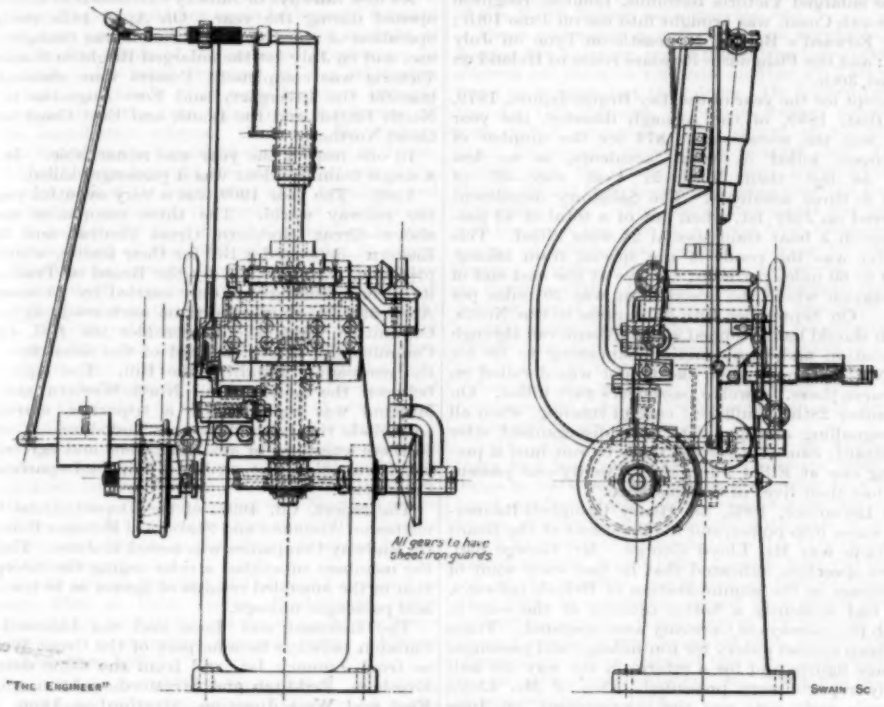


FIG. 157—PNEUMATIC DIE-BATTERING MACHINE—ALLDAYS

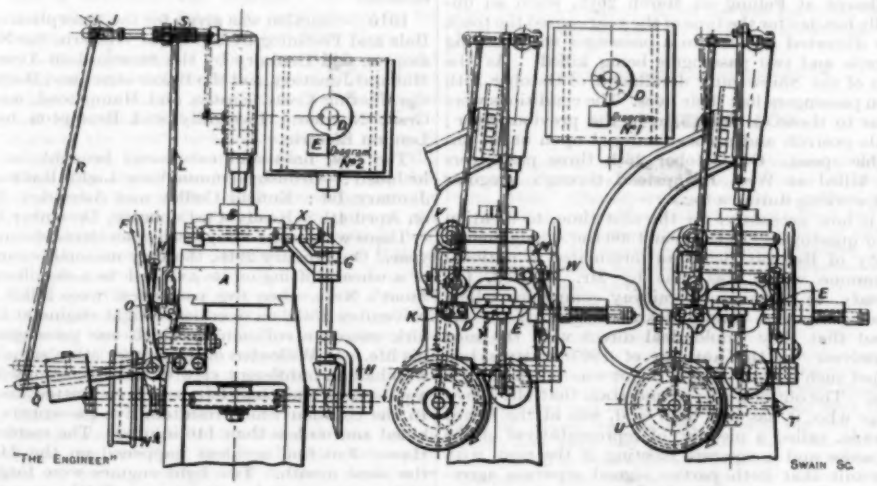


FIG. 158—DIAGRAMS 1 AND 2—MECHANISM OF DIE-BATTERING MACHINE

Finally, we must express our gratitude to many manufacturers and engineers, notably to Mr. Fred Smith, of Cleckheaton, for assistance with information which has helped towards the compilation of these articles, but has not necessarily appeared in print.

IT is just twenty years since the Cobalt silver mines were discovered in Ontario. Last year Cobalt produced over 10,700,000 ounces of silver. Only three camps in the world have produced more silver than Cobalt.

One Hundred Years of British Railways.

No. XXV.*

PART III.—THE LATTER HALF CENTURY.

THE YEARS 1901-1914.

1901.—As was related in the last article, the Central London Railway was opened on July 30th, 1900, and its immediate success led to the promotion of no less than eleven new tube railways in London. Parliament referred the schemes to a joint Select Committee to report upon the subject generally. The Committee reported—Parliamentary Paper 279 of 1901—during the same session, and, among other suggestions, proposed that there should be a more direct control and supervision of all projects for such underground railways.

A Departmental Committee, presided over by Lord Rayleigh, was in January, 1901, appointed to investigate the vibration in buildings adjoining tube railways.

At that time the Metropolitan District Railway had been making considerable experiments with a view to converting, under powers given in 1898, its lines from steam-working to electric traction, and had decided upon the use of direct current, proposed by the American interests, headed by C. T. Yerkes, who controlled that railway. Inasmuch as the Metropolitan Railway worked a certain proportion of the Inner Circle trains over the section of the District lying between South Kensington and Mansion House and was a joint owner of the line thence to Aldgate, it was interested in the system proposed to be employed by the District, and wanted the alternating method of Ganz, of Budapest. As the two companies did not agree on this point, the question was referred to arbitration by the Hon. A. Lyttelton. The hearings were begun in September, 1901, and the award was given in the following December.

Among the local Acts passed in 1901 was one authorising the construction of a mono-rail between Liverpool and Manchester, another for the transfer of the Glasgow and Renfrew to the Caledonian and Glasgow and South-Western jointly, a third for the acquisition of the Devon and Somerset and the Bridport by the Great Western, and a fourth for the Derry Central by the Belfast and Northern Counties.

The new lines and extensions brought into use during the year included the following:—The West Highland extension from Fort William to Mallaig, on April 1st; the Basingstoke and Alton Light Railway, June 1st; Heaton Mersey–Cheadle Heath, October 1st; the extension of the City and South London from Moorgate to the Angel, November 17th.

The safety of British railways reached high-water mark in 1901, as during that year not a single passenger was killed in a train accident. Two passengers and four servants, however, lost their lives as a result of a fire in an electrically operated train at Dingle, Liverpool Overhead Railway, on December 23rd.

Another system of power signalling—the low-pressure pneumatic—was brought into use at Grateley on July 31st.

1902.—The first automatic signalling plant in this country was that installed on the Liverpool Overhead Railway. It was designed by Julius A. Tinmis, and, after careful investigation, was approved by the Board of Trade in December, 1891, and brought into use in March, 1893. At that time little had been done with track circuiting. The first automatic signalling with that system on a steam railway was used in conjunction with the just-mentioned power signalling at Grateley. It extended to Andover, and was brought into use on April 20th, 1902.

On May 1st the Midland, by the opening throughout of the New Mills–Heaton Mersey line, obtained a shorter route to Manchester, and over its own metals to Throstle Nest Junction, immediately outside Manchester Central Station. A loop at Cheadle Heath gave access to the Cheshire Lines, and thence to Warrington and Liverpool. The Whitechapel–Bow was opened on June 2nd. The only serious accident of the year occurred at Hackney on April 25th, when three lives were lost as a consequence of the breakage of the axle of a carriage.

The Railways (Electrical Power) Act—3 Edw. VII., c. 30—gave railway companies power to convert their lines to electric traction without special Acts. In February, 1902, there was published, as White Paper, Cd. 977, the report by Sir Arthur Yorke, the then Chief Inspecting Officer of Railways, on the Metropolitan Railway of Paris.

1903.—The first day of this year saw the opening for goods traffic of the eastern portion of the Great Western's Bristol and South Wales Direct Line, which on May 1st was brought into use throughout for goods traffic. The Burtonport Extension from Letterkenny, 49 miles, was opened on March 9th; the Lanarkshire and Ayrshire from Cathcart to Giffen, on May 1st; the Meon Valley from Alton to Fareham, on June 1st; Mill Hill Park–South Harrow, July 1st; Yarmouth and Lowestoft, Midland and Great Northern Joint, July 13th; Spean Bridge–Fort Augustus, July 22nd; Ballachulish branch, August 21st.

The Mill Hill Park–South Harrow section, just

* No. XXIV. appeared December 12th.

mentioned, was the first portion of the Metropolitan District to be electrically operated. On May 3rd, the Mersey Railway, under powers obtained in 1900, was converted from steam working to electric traction, and it was the first railway in Great Britain to bring such a change into operation.

During 1903 twenty-five passengers were killed in train accidents. Six lost their lives at Waterloo, Lancashire and Yorkshire, on July 15th, owing, it was fairly certain, to the failure of an engine spring; whilst sixteen were killed at St. Enoch's, Glasgow, in a buffer stop collision, caused by the driver's failure to appreciate that he was running into a dock line that was shorter than the others.

Powers were given to the Dublin, Wicklow and Wexford to acquire the Dublin and Kingstown, to the Great Western to absorb the Ely Valley, and to the Highland to take over the Invergarry and Fort Augustus. Other railway events of interest were the appointment, on February 10th, of the Royal Commission on London Traffic; the run on June 1st from Edinburgh to London with the International Telegraph Conference, stopping at Carlisle only. The train left Edinburgh at 1.55 p.m., and ran to Carlisle, 101 miles, in 116 min.; left Carlisle at 3.59, passed Crewe 6.54 (141 miles in 175 min.), and reached Euston 10.1 (158 miles in 187 min.). The load was ten bogie coaches. A non-stop run from London to Plymouth in 233¼ min., with the Prince and Princess of Wales, took place on July 14th.

1904.—The "Cornish Riviera Express" was instituted on July 1st, 1904, and it ran non-stop to Plymouth (North-road), covering the then 246 miles in 267 min.

The Great Northern and City Railway was opened on February 13th, 1904, and the Leek and Manifold on May 15th. On June 1st the new approach, on the west side, to the Central Station, Glasgow, was opened. The electrical operation of the trains on the Liverpool–Southport line was partially begun on March 22nd, and all steam trains were entirely withdrawn on May 13th. Electrical operation in the Newcastle area was brought into use complete at one change on July 1st. The Midland Company's steamship service between Heysham and Belfast was opened on September 1st.

A derailment occurred at Loughor on October 1st, and three passengers were killed. A saddle tank engine was used as a pilot, and after passing the summit of Cockett Bank it was travelling at an unsuitably high speed for the type, with the result that it left the metals. Several accidents occurred during the prolonged spell of fog just before Christmas, the most serious at Aylesbury on December 23rd. A Great Central driver lost his bearings and found himself unexpectedly on the severe curve then at that place, and his train was wrecked almost completely. Though it was a passenger train the only passengers were railway servants, two of whom, together with the driver and fireman of the train, were killed.

The Railways (Private Sidings) Act, 4 Edw. VII., c. 19, was passed, and powers were given to the Cambrian to absorb the Mid-Wales. On April 22nd the Departmental Committee on the alleged preferential treatment of foreign and colonial farm, dairy and market garden produce was appointed. Its report, Cd. 2959, was issued in April, 1906, and acquitted the companies of any breach of the law. The representative of the Board of Agriculture and Fisheries did not share the views of his colleagues and submitted a minority report.

1905.—The year 1905 was a bad year for railway accidents. Its opening days saw that, of January 19th, at Cudworth, where three distant signals and two stop signals were ignored in a fog, with the result that one of the up night Scotch expresses caught up and ran into the up mail. Five passengers were killed. Twenty were killed at Hall-road through an electric train being turned into a siding owing to the signalman not noticing that his facing points were not normal and assuming that the reason he could not lower his signal was that the signalling was out of order. The derailment of a passenger train at Witham on September 1st led to ten passengers losing their lives. In that case the permanent way staff seriously interfered with the safety of the track without giving proper protection. A White Paper Cd. 2538, was issued on May 24th as to the number of derailments of tender and tank engines during twenty years. The former totalled 55 and the latter 54.

The openings of the year included:—The Newquay branch on January 2nd; Cairn Valley, March 1st; Royston–Crigglestone, September 15th; and High Wycombe–Grendon Underwood, November 19th. In the spring of the year a fourth system of power-signalling—the Siemens all-electric—was brought into use at Way and Works Sidings, Derby, and on August 10th the same system was installed at Didcot. The Hall system of automatic signalling was brought into use between Alne and Thirsk on June 13th. Provision for the electrical operation of trains on the Metropolitan District Railway was completed between Ealing and Whitechapel on July 1st, and Inner Circle electric trains were running on September 13th.

The legislation of the year included the Railway Fires Act, 5 Edw. VII., c. 11, and the grant of powers for the Wrexham, Mold and Connah's Quay to be acquired by the Great Central and the Wye Valley and the Lambourne Valley by the Great Western. A report, Cd. 2597, of the Royal Commission on London Traffic was issued on June 26th.

1906.—Powers were given in 1906 for the acquisition of two noteworthy railways: The Waterloo and City by the London and South-Western, and the Lancashire, Derbyshire and East Coast by the Great Central. Among the openings of the year were the Baker-street and Waterloo on March 10th; the Ayr and Girvan Light Railway on May 16th; the completion of the Great Western direct route to Taunton, July 1st; Campbeltown and Machrihanish, September 16th; and the Great Northern, Piccadilly and Brompton, December 15th. The first portion of the enlarged Victoria terminus, London, Brighton and South Coast, was brought into use on June 10th; King Edward's Bridge, Newcastle-on-Tyne on July 10th; and the Fishguard–Rosslare route to Ireland on August 30th.

Except for the year of the Tay Bridge failure, 1879, and that, 1889, of the Armagh disaster, the year 1906 was the worst since 1874 for the number of passengers killed in train accidents, as no less than 58 lost their lives in that way—57 of them in three accidents. The Salisbury derailment occurred on July 1st, when out of a total of 43 passengers in a boat train special 24 were killed. This disaster was the result of the special train taking, at 50 to 60 miles per hour, a curve at the east end of the station where the speed limit was 30 miles per hour. On September 19th an express to the North, which should have stopped at Grantham, ran through the station and, the junction happening to lie for the Nottingham branch, the tender was derailed on the curve there. Twelve passengers were killed. On December 28th, insufficient care in running, when all the signalling arrangements were disorganised after a blizzard, caused a second train to run into a preceding one at Elliot Junction. Twenty-one passengers lost their lives in that instance.

In December, 1905, Sir Henry Campbell-Bannerman came into power, and his President of the Board of Trade was Mr. Lloyd George. Mr. George had, by his speeches, indicated that he had some want of confidence in the administration of British railways, and had evidently a better opinion of the way in which the railways of Germany were operated. There had been a great outcry for ton-mileage and passenger mileage figures and for a reform in the way the half yearly reports were presented. One of Mr. Lloyd George's early acts was the appointment, on June 15th, 1906, of a Departmental Committee to report as to the accounts and statistical returns rendered by railway companies. On July 18th the Scotter Vice-regal Commission was appointed to inquire into the working of the railways in Ireland.

1907.—The only new railway of importance opened in 1907 was the Charing Cross, Euston and Hampstead. Moreover, the only extensions of note were those of tube railways—the Baker-street and Waterloo to Marylebone on March 27th and to Edgware-road on June 23rd, and the City and South London from the Angel to Euston on April 11th. Powers were given for the Cheadle Railway to be acquired by the North Staffordshire and the Limavady and Dungiven by the Midland Railway as part of the Northern Counties system. Crewe enlarged station was completed during the year.

Among the accidents of 1907 may be noted a derailment at Felling on March 26th, when an unusually hot day for the time of the year caused the track to be distorted and led to a passenger train leaving the rails and two passengers being killed. As the result of the Shrewsbury derailment of October 15th eleven passengers lost their lives. The conditions were similar to those at Grantham in the previous year; signals overrun and a curve entered upon at an unsuitable speed. On October 26th three passengers were killed at West Hampstead through irregular block working during a fog.

It is now necessary, for the first time, to mention labour questions. In the year 1906 the Amalgamated Society of Railway Servants formulated a national programme which was sent by Mr. R. Bell, the secretary, to the various railway companies which either ignored or simply acknowledged it, on the ground that they would deal direct with the men themselves. In the autumn of 1907 matters had reached such a state that a ballot was taken as to a strike. The outlook was so uncertain that Mr. Lloyd George who, it has just been said, was at the Board of Trade, called a meeting of representatives of the companies and a separate meeting of the men, with the result that both parties signed separate agreements on November 6th, 1907, to accept a system of conciliation and arbitration. The "Conciliation Scheme of 1907" was the result. It is referred to again below under the year 1911.

1908.—It will be convenient to open the notice of the events of the year 1908 with a continuation of the immediately preceding paragraph. The meetings Mr. Lloyd George had with the companies at, and subsequent to, the labour settlement of November, 1907, evidently opened his eyes as to the difficulties the railways had to contend with, and thereafter he had more sympathy for them than he had previously shown. One result was what was called the Board of Trade Railway Conference. It was set up in February, 1908, without any rigid terms of reference.

Another very important event of the year 1908 was the agreement between those hitherto great rivals, the London and North-Western and the Midland, which was announced by Lord Stalbridge at the London and North-Western meeting on August 14th, and by Sir Ernest Paget at the Midland meeting on the preceding day. It was an agreement for pooling and dividing the working of competitive traffic between the companies. During the same year the fusion of the Great Northern, Great Central and Great Eastern was proposed. In the closing days of the year the North London Railway, under powers given in 1861, when the line was to be extended to Broad-street, passed into the possession of the London and North-Western.

No new railways or railway extensions of note were opened during the year. On April 14th electrical operation of the Heysham branch was brought into use, and on July 1st the enlarged Brighton Station at Victoria was completed. Powers were obtained to transfer the Invergarry and Fort Augustus to the North British and the Louth and East Coast to the Great Northern.

In one respect the year was remarkable. In not a single train accident was a passenger killed.

1909.—The year 1909 was a very eventful year in the railway world. The three companies named above—Great Northern, Great Central, and Great Eastern—deposited a Bill for their fusion, which, in principle, was accepted by the Board of Trade, but its second reading was only carried by 25 votes on April 5th. Certain conditions were made as to the Committee which should consider the Bill, *e.g.*, a Committee of fifteen, instead of the usual five, and the companies withdrew the Bill. The agreement between the London and North-Western and the Midland was replaced by a tripartite agreement to include the Lancashire and Yorkshire. A sequel to these questions of amalgamations and agreements was the appointment, on June 17th, of a Departmental Committee.

The report, Cd. 4697, of the Departmental Committee on Accounts and Statistical Returns Rendered by Railway Companies was issued in June. Three of the members submitted a rider urging the incorporation in the amended returns of figures as to ton-miles and passenger mileage.

The Liskeard and Looe and the Liskeard and Caradon railways became part of the Great Western as from January 1st, and from the same date the Evesham, Redditch and Stratford-on-Avon and the East and West Junction, Stratford-on-Avon, Towcester and Midland Junction became the Stratford-on-Avon and Midland Junction Railway.

The openings of the year included the Strabane–Letterkenny on January 1st; Levenshulme–Wilmslow, February 1st; and Crigglestone–Thornhill, July 1st; the Water–Orton–Kingsbury deviation was opened on May 2nd; the Cunard Steamship Company began to use Fishguard on the eastbound journeys of the New York–Liverpool mail boats, beginning with the Mauretania, on August 30th; and on December 1st the South London electrification was opened throughout.

A derailment at Sudbury, London and North-Western, on July 2nd, owing to the premature restoration of the signals, caused the death of one passenger, but it was the only fatal accident of the year, and the only fatal accident between October 26th, 1907, and January 29th, 1910, a period of two years and three months.

1910.—Sanction was given for the absorption of the Bala and Festiniog by the Great Western, the Northampton and Banbury by the Stratford-on-Avon and Midland Junction, and the Baker-street and Waterloo, the Charing Cross, Euston and Hampstead, and the Great Northern, Piccadilly and Brompton by the London Electric.

The new lines and extensions brought into use included:—Grimsby–Immingham Light Railway on January 1st; Enfield–Cuffley and Ashenden–Aynho on April 4th; Keady–Castleblaney, December 1st.

There were some disagreeable accidents during the year. On January 29th, the very unusual occurrence of a wheel shifting on its axle led to a derailment at Stout's Nest, when five passengers were killed. On November 25th, an overlooked light engine at Ormskirk caused a collision in which one passenger lost his life. At Willesden on December 5th a signalman, who had an indifferent view of the line, assumed that a passenger train had left, and he admitted another. In the collision which resulted, five passengers were killed and no less than 146 injured. The memorable Hawes Junction accident happened on the 24th of the same month. Two light engines were forgotten and were run into by an express. Twelve passengers were killed. Fire subsequently broke out in the *débris* and six of the eight vehicles were destroyed. A remarkable feature of an accident at Roscrea on July 19th should be mentioned. When it was reported to the Board of Trade, 76 passengers claimed that they were injured, but eventually no less than 509 claims were sent in!

1911.—The Railway Companies (Accounts and Returns) Act—1 & 2 Geo. V., c. 34—was the sequel to the Departmental Committee of 1909–10. It was to come into force from January 1st, 1913, and thereafter there would be annual instead of half-yearly reports and meetings.

The first section of the Cardiff Railway was brought into use on March 1st, 1911, and of the Shropshire and Montgomery on April 13th. The London, Tilbury

and Southend was acquired by the Midland, and on October 31st the Invergarry and Fort Augustus was closed, as its operation did not pay the working company, the North British.

The leading event of the year was the general railway strike of Friday, August 18th, and Saturday, August 19th. The summer had been unusually hot, which is a condition often accompanied by labour unrest. There had been trouble with the dockmen, and then among the transport men, and it spread to the railwaymen. To understand their grievances, the allusions to a national programme in 1906 and the conciliation scheme in 1907 must be remembered. A feature of the latter was that any point adjudicated upon could not again be brought forward for a certain period. The men made the mistake of putting in the whole of the national programme as their claim. It, being rejected by the arbitrator, could not, as a whole or in part, be again brought forward, and so the men were little the better off for the conciliation scheme. Although Mr. Sydney Buxton was then the President of the Board of Trade, Mr. Lloyd George brought the representatives of the companies and of the men practically together, and the strike was ended on the promise of the Government at once to set up a Royal Commission to conside the working of the 1907 scheme, and to secure from Parliament powers for the railway companies to increase their rates to meet any further cost that any improvement in the conditions of the men might entail. The Royal Commission received its warrant on August 22nd, sat on the following day, and then from day to day on twenty-nine days from the 28th, to hear evidence from sixty-seven witnesses, and reported—Cd. 5922—on October 18th. A new scheme was recommended, which included "recognition" of the trades unions. The last was a very sore point with the companies, but yet we find six labour leaders sitting down on December 11th, with Mr. Claughton, the then chairman of the London and North-Western and three general managers and mutually agreeing to certain amendments in the scheme proposed by the Royal Commission.

The only serious accident of the year happened on January 23rd at Coke Ovens, Pontypridd, when irregular block signalling led to a passenger train running into a standing mineral train. Eleven passengers were killed.

1912.—The year 1912 was uneventful. The Cork City Railways were opened on January 1st; the Selby-Goole on May 1st; the Croxley Green branch June 15th; and the Central London extension from the Bank to Liverpool-street on July 27th. The fifth and sixth lines between Willesden and Harrow were brought into use on July 1st, and Immingham Docks on the 22nd idem.

There were two serious accidents. On June 21st a passenger train was derailed on Charlestown Curve, because, in the inspecting officer's opinion, a heavy tank engine of the particular type employed on that occasion was run too fast, thereby throwing excessive stress on to the permanent way. Four passengers were killed. On September 17th a passenger train was travelling through Ditton, near Liverpool, and was turned on to the slow line. The driver had never before driven a train over the slow line, and he did not know the road sufficiently to be aware that, whilst normal speed could be maintained on the fast line, a reduction was necessary for the slow. The result was that the train was derailed and he, his fireman and thirteen passengers lost their lives.

1913.—The opening of the year 1913 saw the fulfilment of the Government's promise to secure legislation which would pass on to the public the increased cost resulting from the improvement in the conditions of the men which followed from the work of the improved Conciliation Boards. True, a Bill to achieve this object was brought in on April 1st, 1912, but the Government took advantage of the opportunity to attempt to provide for some of the points often in dispute between the companies and traders, *e.g.*, owner's risk conditions. That Bill, as a whole, pleased neither party and it was dropped, and Railways Bill No. 2 of two clauses was brought in on December 4th, 1912. It, also, was disliked, especially by the Government's own supporters, and it was not until Mr. Asquith adopted a firm attitude that, on March 6th, 1913, it was read a second time and eventually became the Railway and Canal Traffic Act, 1913. Even then the matter was not disposed of. The increase made under the Act was one of 4 per cent. on specified items. That increase was opposed by certain traders and recourse had to be had to the Railway and Canal Commission. The arguments were being heard when war broke out and were by agreement suspended until the autumn of 1919, and on March 16th, 1920, judgment was given for the railway companies.

On October 24th, 1913, it was announced that the Government had appointed a Royal Commission, to be presided over by Lord Loreburn, to consider the relations between the railways and the State. This particular event may at once be disposed of by recording that the inquiry was still in being, and had been adjourned for the summer vacation when war broke out in August, 1914. A formal meeting was held on January 21st, 1915, which decided that the sittings should not be resumed until further notice and no more was heard of the matter.

The fifth and sixth lines from Willesden were extended from Harrow to Bushey and the new curve from Bushey to the Rickmansworth branch at Watford, High-street, was opened on February 10th. The light railway from Elsenham to Thaxted was opened on April 1st, and the line from Kirkstead to Little Steeping on July 1st. Part of the Mansfield Railway was brought into use on June 16th, and the Baker-street and Waterloo was extended from Edgware-road to Paddington on December 1st. The North British Company's docks at Methil were opened on January 22nd, the East London Railway, after conversion to electric traction, was reopened on March 31st, and the Invergarry and Fort Augustus was again in use as from August 1st in anticipation of the North British acquiring the line.

There was again a run of serious accidents. On August 8th a driver, under mitigating circumstances, allowed his train to run into another at Yeovil and three passengers lost their lives. On September 2nd the Ais Gill collision, in which sixteen passengers were killed, occurred. The driver of an express from Edinburgh presumably missed his distant signal, and the home signal was lowered sooner than it should have been considering that the starting signal was "on." The last-named signal was ignored and the train ran into an express from Glasgow, the engine of which was "stalled" owing to want of steam. A collision at St. James, Liverpool, occurred on October 15th. In that case a signalman mistook a block signal and allowed a second passenger train to start before the first was clear. Six passengers were killed. Ten days later three lost their lives in a collision in a fog at Waterloo Junction.

Sanction was given for the acquisition of the Great Northern and City by the Metropolitan and the Vale of Rheidol by the Cambrian.

1914.—Up to the outbreak of war on August 4th there had been only two fatal passenger train accidents in 1914, and one of them was due to a cloudburst on June 18th, which washed away an underbridge at Carr Bridge, together with part of a train which happened to be passing over it. Five passengers were drowned. In the other a youth, who was looking out of the window, was killed at Cannon-street on June 27th, in a collision caused by a driver starting against his signal. Whilst out of the purview of the present article, it may be added that, despite the disorganisation which resulted from the mobilisation of troops, railwaymen enlisting, &c., there was no other serious accident in 1914.

Traffic over the bridge at Carr Bridge was resumed on July 13th. The Charing Cross, Euston and Hampstead was extended on April 6th from its station in the Strand to one under the Metropolitan District on the Embankment. On June 26th King George Dock at Hull was opened. Electrical operation between Willesden and Earl's Court—the first of a big scheme of the London and North-Western—was started on May 1st.

The Government, on February 13th, as a result of a discussion on the reply to the King's Speech, promised an inquiry into the working of the Railway Employment (Prevention of Accidents) Act, 1900. This inquiry was opened on June 9th, and was continued until July 24th, when it was adjourned until October 6th. As witnesses from the companies were then to reply to the exceedingly poor case made by the men, it is to be regretted that the inquiry could not be resumed. It is a satisfaction to the companies that the Government, when the war was over, decided that there was no need to resume the sittings.

SIXTY YEARS AGO.

The opening of the Clifton Suspension Bridge—on December 8th—was recorded in our issue of December 16th, 1864. The report conjures up a gallant picture, typical of the ceremonies with which our fathers and grandfathers were wont to endow the completion of any great new work. All sorts and conditions attended to celebrate the event—lords-lieutenant, magistrates, sheriffs, foreign consuls, clergy, merchant venturers, foresters, druids, shepherds, sailors, soldiers, yeomanry and volunteers, together with a "large muster of gentlemen who came in uniform of some kind or other." The occasion seems to have been worthy of this brave showing. For two hundred years the want of a structure uniting Gloucestershire and Somersetshire had been keenly felt. One hundred and eleven years had elapsed since the first sum of money was secured towards the end in view. Thirty-four years had passed since the work was begun. Commenced by others, it was finished by the Clifton Bridge Company. That company bought the chains of the old Hungerford Bridge across the Thames at Charing Cross for £5000, and slung them across the stone towers erected at Clifton by Brunel for the first company to attempt the project. These towers were acquired for the sum of £2000. With its span of 702ft. 3in., the Clifton Bridge, as completed, formed at that date the longest and highest chain bridge in the world, although two other suspension bridges—at Niagara and Fribourg—using wire ropes instead of chains, had longer spans. With a load of 70 lb. per square foot on the platform, the total "strain" on the bridge was given at 2094 tons. The maximum stress on the ironwork corresponding to this load was 4¼ tons per square inch, or a little less than one-fourth of the ultimate strength of the material. . . . Elsewhere in the same issue we recorded the launch of a Turkish ironclad frigate, the Sultan Mahmoud, from the yard of the Thames Ironworks at Blackwall. With this launch, it was stated, the list was almost completed of the European Powers which had sought the aid of this country in carrying out the new idea of naval construction. With one or two exceptions, there was not a foreign ironclad of note which had not been constructed here. To-day there is little about the Turkish vessel which is of great interest in itself. But, as illustrating the conditions of the times, it may be remarked that her nominal horse-power was given at 900, although, it was added, her engines could with safety be worked up to 3000 horse-power. Again, dealing with her armament, we stated that she would have twenty guns of the heaviest calibre "which we yet know how to construct, or at least to use with safety to the gunners."

THE STEAM YACHT THALASSA.

A NOTABLE steam yacht of the year is the Thalassa, which was built by John Brown and Co., Limited, at Clydebank, to the order of Mr. Eugene Higgins, and to the designs of G. L. Watson and Co., naval architects, Glasgow. She has a Thames measurement of about 700 tons, and is of the built-up type, with a considerable amount of accommodation for her tonnage. The following are her principal dimensions:—Length over all, 197ft.; breadth, 29.3ft.; and depth, 15.4ft. Triple-expansion steam engines, designed by the builders, with four cranks, two low-pressure cylinders being used, are installed. The cylinders are 12in., 19½in., 22in. and 22in. bore respectively, with a stroke of 20in. Steam is supplied from two oil-fired boilers, and sufficient fuel is carried for long ocean passages. Excellent accommodation for the owner, his guests and the officers and crew are provided. The Thalassa is somewhat unconventional in appearance, for she has a straight bow and a cruiser stern. These features, though somewhat unusual in a yacht of her size, are very practical, as was shown by recent cruises off the North of France and in the Mediterranean, where the good sea qualities of the boat were tested.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

FLETTNER ROLLER SHIP.

SIR,—Your simple experiments and the interesting account of your correspondent on the spot have done much to dispel the mystery which surrounded the early announcements of this invention. It is surely the same (or analagous) effect as is secured by the Australian aborigine when throwing the boomerang, the "Googlie" bowler or the base ball "pitcher," not to name the underspin of the lofted drive, or the more scientifically appreciated "drift" of projectiles fired from rifled pieces of ordnance.

Be that as it may, your correspondent is clearly of the opinion that it is a distinct improvement on the mast and sail equipment of an old-fashioned topsail schooner. The question is, however, how would it compare with the clean design of the Yankee "Fore-and-After" with her power handled canvas; in this case one would get a distinct comparison between rolling the wind and angling it.

One finds it difficult to understand the automatic decrease in thrust as the wind velocity increases, nor does that altogether sound like efficient propulsion, since within the limits of safety the harder it blows the more should a ship make of it.

Taking the invention on the face value of the reports so far to hand, one cannot see it making much headway in this country; but it will be very interesting to see the vessel over here and, above all, to learn how she carries herself in a strong blow. Few seamen of the old school I fear would be found to take command of her on the grounds of appearance alone. But handsome is as handsome does, of course. One wonders also what would occur if the rotating motors failed in a breeze of wind, and the full weight of a beam wind caught the towers when stationary and, therefore, presumably subjected to full thrust.

S. P. CHRISTIE.

Pembrokeshire, December 16th.

THE "CHIMNEY" CONDUIT.

SIR,—May I be permitted to point out an error of fact in the last paragraph of the article on the "Chimney" Conduit which appeared in your issue of the 12th inst.? It is a mistake not infrequently made and possibly unimportant in itself, but to allow it to pass uncorrected might make it appear that I claim credit which is not due to me.

The secretary—or to be more accurate, the assistant secretary—of the Society of Antiquaries of London is not Mr. C. L. Kingsford, F.S.A., whose work on all matters connected with the history and antiquities of London is so well known, but his kinsman, the writer of this letter.

H. S. KINGSFORD.

Burlington House, Piccadilly, W.1,
December 13th.

FACTORY ENGINEERS' SALARIES.

SIR,—Will you allow me to ask the opinion of your readers who are engineers in charge of factory machinery, what they consider is a fair salary for an engineer who has charge of a factory of the following size:—The plant consists of three large Lancashire boilers, steam, Diesel, and electrical plant totalling 1250 horse-power. There are a large number of motors, big and small, to maintain, and heating and drying plants to keep in order. In addition, the engineer has a staff of about forty-six men, comprising fitters, carpenters, painters, electricians, labourers and odd men. The engineer is responsible for all extensions to the plant and buildings.

FACTORY ENGINEER.

December 13th.

A CORRECTION.

SIR,—In your editorial of October 17th, "Hardness Testing Again," in which you kindly refer to my method of cold-working hardened steel balls, the title of Doctor is mistakenly connected with my name. The same mistake having also been made elsewhere, I should be much obliged if you would assist me in correcting it by publishing these lines.

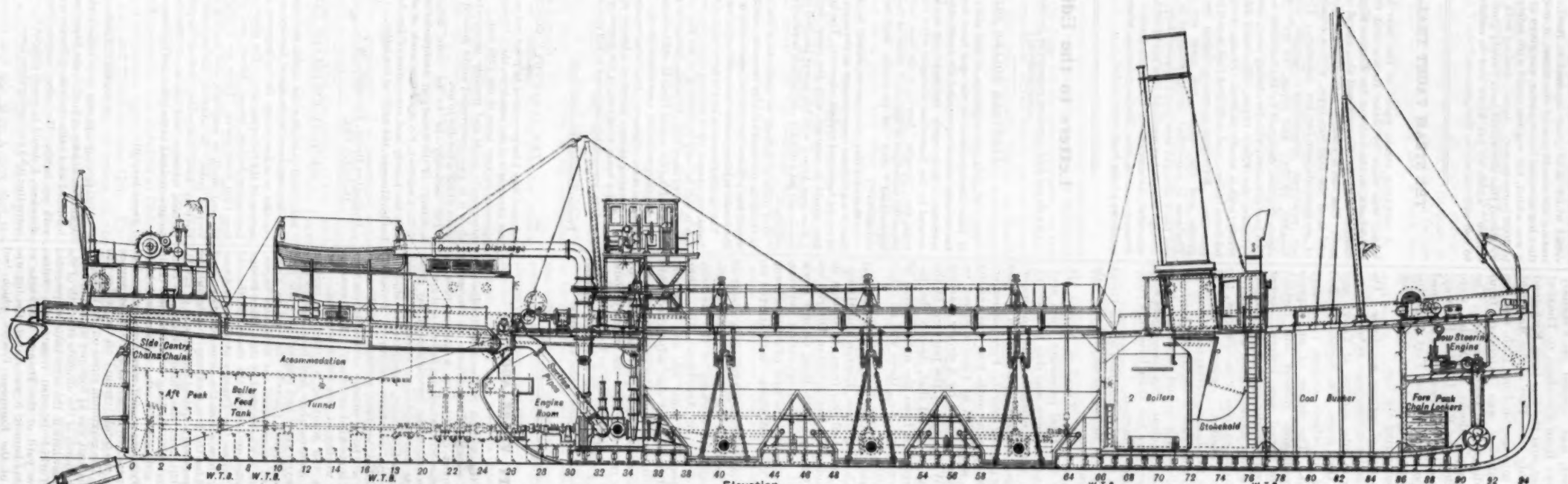
AXEL HULTGREN.

Gothenburg, December 9th.

THE TRAILING SUCTION STERN-WELL HOPPER DREDGER KAIONE

FLEMING AND FERGUSON, LIMITED, PAISLEY, BUILDERS AND ENGINEERS

(*For description see opposite page*)



"THE ENGINEER"

SWAIN Sc.

Some Recent British Dredgers.

IN placing on record the advances made in shipbuilding and marine engineering, which to-day, as in the past, secure to Great Britain the leading place among the world's shipbuilding countries, there is perhaps a tendency to emphasise the larger and more magnificent ships at the expense of smaller and humbler craft. Especially is this so with regard to special types of vessels, such as dredgers and harbour vessels. At the Wembley Exhibition some interesting examples of recent dredgers were shown in model form by three Scottish builders, and in the present article it is proposed to deal briefly with them. William Simons and Co., Limited, of Renfrew, chose four examples of the suction type of dredger wherewith to illustrate particular problems with which the firm has been called upon to deal. On page 698 we reproduce a photograph of the dredger Sir George Lloyd. This particular dredger is of the cutter suction type, and it was specially built for work at Bombay in connection with the Back Bay reclamation scheme, which is now being carried out at that port. The special cutter shown on the end of the raised suction frame is driven by a compound steam engine, while a triple-expansion engine serves to work the centrifugal suction and delivery pumps. The machinery was designed, we are informed, to dredge about 2000 yards of soil per hour, from depths up to 70ft., and to discharge the material through a floating pipe line to a distance of 5000ft. from the dredger. The pump capacity is, however, not large enough for some sections of the reclamation work, where the material is required to be transported to a distance of 10,000ft., and for such sections the dredger has been designed to work in conjunction with a floating pumping station, also built by Simons, Limited. The station is equipped with pumps capable of discharging the material over a distance of 5000ft., and to raise it at the same time to a height of 16ft. above water level. As shown by our illustration, the Sir George Lloyd is a two-funnelled vessel of pleasing appearance, and as regards deck accommodation is well equipped for her work. She is propelled by a twin set of compound surface-condensing engines.

Another illustration given on page 698 shows another dredger of outstanding design which the firm also built for the Government of India. In the Ronaldshay we have a dredger built specially for the work of opening new waterways and for widening and deepening river channels and existing canals. The special feature of the design is the arrangement of a battery of six cutters in open wells at the forward end. These cutters, with their driving shafts, are clearly shown at the right-hand end of the general view of the ship—on page 698. They are designed for excavating stiff material, and are capable of dredging adhesive clay to a total width of 45ft. when the vessel is moving slowly ahead.

At the forward end of the ship there are three frames, each with two suction orifices, carried in three open wells. These frames are controlled by wire rope hoisting gear, which is steam operated and so arranged that the cutters and suction pipes may be used independently or together as required. Provision is made to dredge to a total depth of 30ft. below water level. The engine driving the cutters is of the compound reciprocating type, and two main centrifugal pumps are provided, each of which is driven by a vertical triple-expansion engine. Water-tube boilers are used for generating steam for the propelling, dredging, and pumping engines, and the auxiliary machinery includes an electric lighting set and a refrigerating plant. At the official trials the Ronaldshay made one cut 40ft. in width, 10ft. 9in. in depth, and 300ft. in length in the short time of 40 minutes. The amount of material removed during this cut was, we are informed, 5354 cubic yards, which represents the large output of some 10,000 tons per hour. From the dredger a pipe line is run over 600ft. to a terminal pontoon, where it is raised 25ft. above water level, and carried over the river bank to a point 150ft. distant from the floating pipe line.

Other dredgers shown in model form included the Balari, which is fitted with the Simons patented sand baffling arrangement. This dredger works on the Hooghly River, and during her trials she filled her hopper of 3000 tons capacity in the short time of 19 minutes.

Another dredger, the M.O.P. 210 C., which was built for the Argentine Government, is of the type which works whilst steaming slowly ahead. She has a hopper capacity of 2500 tons, and is fitted with the builders' patented suction keels, arranged so that the load in the hopper can be conveniently discharged overboard for reclamation work. The Corozal, again, is a bucket type of dredger, which was constructed for work on the Panama Canal. She has a capacity of 1200 tons, and her ladder with its buckets weighs close upon 240 tons. Besides the types of dredger we have mentioned, William Simons and Co., Limited, are builders of dipper and drag-line dredgers of the latest types.

Lobnitz and Co., Limited, also of Renfrew, was represented by a comprehensive series of models. From these we have singled out for special mention the patented dipper dredger Lucayan—see page 698—which was built to the order of the Government of the Bahamas. This dredger may be claimed to be one of the largest and most complete dredging machines in the world, and she represents a type for which, we understand, that Messrs. Lobnitz are the sole constructors in Great Britain.

The following are the principal dimensions of the Lucayan :—

Overall length	110ft.
Overall breadth	44ft.
Overall depth	12ft.
Maximum dredging depth	40ft.
Maximum reach when dumping	50ft.
Clear height of dump above water	16ft.
Average output	480 cubic yards, or 650 tons per hour.

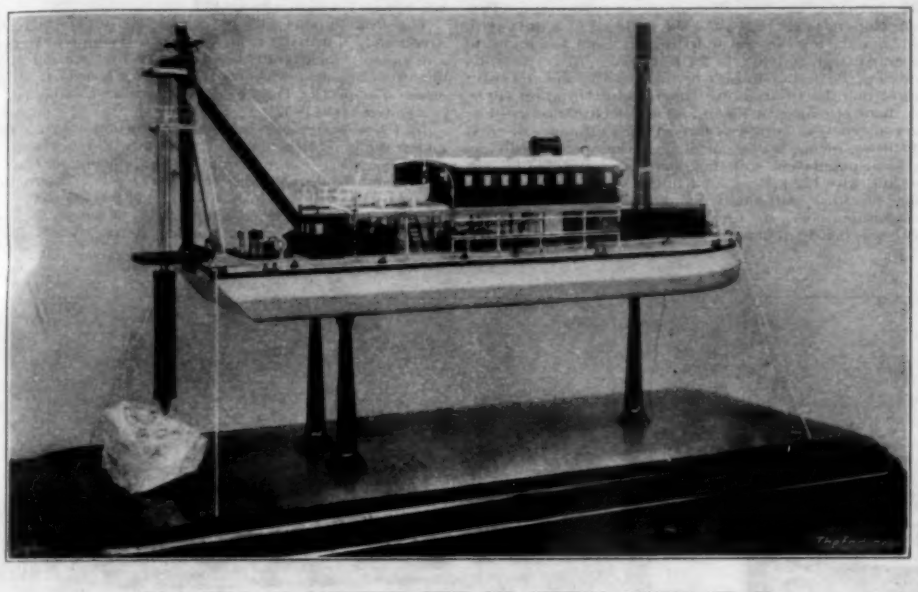


FIG. 1—MODEL OF ROCKCUTTER BUILT FOR BERMUDA—LOBNITZ AND CO.

As will be seen from the illustration on page 698, the dredger is designed to work on two main spuds and one stern spud, and when dredging part of her weight is taken by the main spuds which serve to hold her in position and make her independent of swell or local currents. Mooring chains and rope wires are thereby dispensed with, which facilitates the dredger being used in restricted waterways or canals, where there may be at the time vessels passing. Equally well it may be used in a confined corner of a harbour. The main spuds are 4ft. square, and each weighs 30 tons. For the dipper arm a laminated construction of wood and steel is employed, which is stated to give a saving in weight and increased strength. Another advantage claimed for the composite arm is its elasticity and the avoidance of loose rivets. It may be noted that the dipper arm is actuated by the boom engine by means of parallel hoisting wires with specially large sheaves. The rope hoisting gear was adopted in preference to rack and pinion gear, as giving greater flexibility and being easily replaced in case of breakage, while wear and tear are, it is claimed, reduced. The bail is cast solid on the dipper, thereby giving an open topped bucket, which may be used for lifting heavy boulders. The boom is supplied with an auxiliary lifting gear for lifting-off large rocks and boulders which may be brought up by the dipper.

The bucket is made to swing through 180 deg., and the swinging engine and the main turntable are placed at main deck level, thereby increasing the stability of the ship and enabling the operators' stand to be placed on the bridge overhead. From this control platform the operator may have in view the whole of the dredger machinery, and he has a full and unobstructed view of the work which is being done.

By unshipping the dipper the dredger can be used as a 60-ton floating crane. Winches are provided for handling barges on either side of the ship.

There is cabin accommodation for three operators and crew, all the usual facilities being provided. Electric light is fitted throughout, and two lifeboats are carried. This vessel was constructed to the highest Lloyd's and Board of Trade requirements.

Another exhibit—illustrated by Fig. 1—was a model of an improved rock cutter, which was built for the Crown Agents for the Colonies service at Bermuda. This ship has a length of 110ft., with a breadth of 33ft., and a depth of 8ft., and she is designed to break rock under water at any depth varying from 6ft. to 60ft., and with an output for rock of average hardness of 10 cubic yards per hour.

A feature of the vessel is the firm's patented form of under-water guide, which may be suspended at any depth, so that its lower end is only about 2ft. from the surface of the rock which is to be broken. When the rock-cutting chisel is raised and dropped, the guide causes a powerful stream of water to impinge upon the rock surface, which cleans away any mud or sand, and allows the chisel to strike a clean blow. The builders state that the cost of breaking rock by this method is less than half that occasioned by drilling and blasting, and the broken rock is more easily dredged. Where a swell exists the rock-cutting barge may be furnished with spuds which enable the rock cutter to work quite steadily, even against a moderate swell.

FIG. 2—THE BUCKET HOPPER DREDGER SIR WILLIAM MATTHEWS—FLEMING AND FERGUSON

Among other exhibits there were models illustrating the trailing suction dredger K'uai Li, built for the Hai Ho Conservancy Commission for work on the Taku Bar; the Lady Clifford, a 2000-ton suction hopper dredger ordered by the Crown Agents for the Colonies for service at Lagos, West Africa; and The Chief, a bucket dredger built for the Union Government of South Africa. Another model showed a drag-line excavator, which Lobnitz and Co., Limited, built for service in the Sudan.

Fleming and Ferguson, Limited, of Phœnix Works, Paisley, also showed a number of interesting models illustrating the various kinds of dredging plant, rock breaking and harbour plant constructed by them.

The drawing we reproduce on page 694. serves to illustrate the Kaione, a trailing suction stern-well hopper dredger of the Frühling type, which was built for Wanganui Harbour Board in New Zealand. She has an overall length of 200ft., with a breadth of 35ft. and a depth of 16ft. The centrally placed hopper has a capacity of 1000 tons, and is of the self-discharging type. A trailing suction frame having a width of about 10ft., is fitted, and it is provided with water jets for breaking up the sand. Where stiffer material than sand is required to be dealt with, rotary cutters, driven by gearing from an independent engine, are employed. The drawing shows the general arrangement of the propelling and hoisting and cutter gear engines, as well as the pumping machinery.

A feature of the Kaione is the manner in which the dredged material may be disposed of in various ways. As a rule, the material raised by the suction pump is discharged directly into the hopper. On the other hand, it can be dealt with by barges moored alongside, while bottom doors are provided in the hopper through which the material can be discharged directly into the sea. In the event of material being required for reclamation purposes, it may be withdrawn from the hopper by a sand pump and delivered ashore by a floating pipe line. Pipes up to 5000ft. in length can be usefully employed.

The twin sets of propelling machinery are designed to give the vessel a speed of 10 knots, and the pumps have a capacity of about 3000 tons per hour. Each suction pipe has a diameter of 16in., and the pumps are designed to operate with the suction pipe lowered to a depth of 40ft. below the water line.

Another example of Fleming and Ferguson's work is the stern-well bucket type of hopper dredger, Sir William Matthews, which we illustrate in Fig. 2. This vessel has a length of 230ft., with a breadth of 44ft. and a depth of 17ft. From the illustration referred to, it may be noted that the vessel is provided with a fore-peak similar to that used in an ordinary cargo ship. With such a peak the makers claim that the boat is capable of weathering a rough sea much better than would be the case with a bow-well dredger of the old pattern. The Sir William Matthews is essentially a type of dredger which can be employed to discharge at sea the material dredged, even in a heavy sea. The hopper capacity is 1200 tons, and the machinery is designed for an output of about 1000 tons of material per hour, removed from a depth of 45ft. below the water level. The propelling machinery fitted is capable of conveying the fully loaded vessel out to sea at a speed of 10 knots.

Other interesting plant shown by the builders included models of a 60-ton floating crane built for the Calcutta Port Commissioners, and a pontoon fitted with the firm's patented under-water rock-breaking equipment. A special feature of the design which was shown was the bolster block, that guides the chisel, which is capable of being raised or lowered so as to permit of a standard length of chisel being employed for all depths of work. With the equipment shown, the makers claim that about 100 cubic yards of rock may be broken per working day, with the expenditure of about 1 ton of coal. A chisel of approximately 20 tons weight is used, and with 130 to 150 blows per hour about 10 cubic yards of rock can be broken up. Only four men are required to work the whole of the plant, which is thus quite economical in operation.

This brief résumé of recent dredging machinery shows that there is no lack of initiative among British builders in applying past knowledge and new principles to the problems with which they are faced. There is perhaps no more important work than that of maintaining for our shipping trade good and deep harbours and rivers throughout the world, and it may be hoped that with reviving trade and more settled times a large share of the orders for new dredgers will be secured for home builders.

Railway Centenary in Austria.

(From a Correspondent.)

VIENNA, November 11th, 1924.

AUSTRIA is celebrating her railway centenary. On September 7th, 1824, Emperor Francis Joseph I. granted an exclusive concession to Franz Anton Gerstner, Professor of Practical Geology at the Vienna Polytechnic, for the building of a railway between Mauthausen, near Linz, and Budweis, linking up the Danube with the Moldau. The southern terminus was later changed from Mauthausen to Linz, and the line was known as the Linz–Budweis Railway. Constructed between 1825 and 1832, and partially opened for traffic in 1827, it was the first railway built on the Continent. The coaches and wagons were drawn by horses. Steam railways came some time later, the first being opened on May 3rd, 1835, between Brussels and Mechlin; and in Austria, on November 23rd, 1837, between Vienna—Florisdorf—and Wagram. Professor Gerstner first suggested the building of a railway in 1807, mainly for the transport of salt from the mines of Upper Austria and Styria to Bohemia. After carefully surveying the proposed route he went to England and spent several months in studying the railway situation there, and then returning to Vienna he obtained his concession. The construction work was carried out in the face of great difficulties, owing to lack of money, the open hostility of the local population and the shortage of suitable la' our. The line was 129 kiloms. in length, single track, with a gauge of three and a-half Vienna feet—1.106 m. The construction cost, in English money, about £150,000, which was nearly double the original estimate.

In constructing the line Gerstner departed from the English methods and laid the rails on dry stone piers, a foot in width at the top. As these, however, proved too weak he afterwards filled up the whole space between with stones, which added enormously to the cost.

The track consisted of longitudinal wooden sleepers, 158 × 184 mm., laid edgewise, and on these were fastened flat iron rails 53 × 9 mm. Cross sleepers were laid at distances of 1.90 m. apart.

The rolling stock was constructed on the English pattern, and comprised, in the last years of operation, 1056 goods wagons and trucks and 38 first and second-class passenger coaches. These latter were built with the driver's seat at each end so that they could move in either direction,

ORIGINAL PASSENGER COACH—LINZ-BUDWEIS RAILWAY

as there was no means of turning them round. The first-class coaches, later converted into second-class, carried four passengers. The third-class were merely open trucks, some with a roof but the sides open, leaving the occupants exposed to the weather.

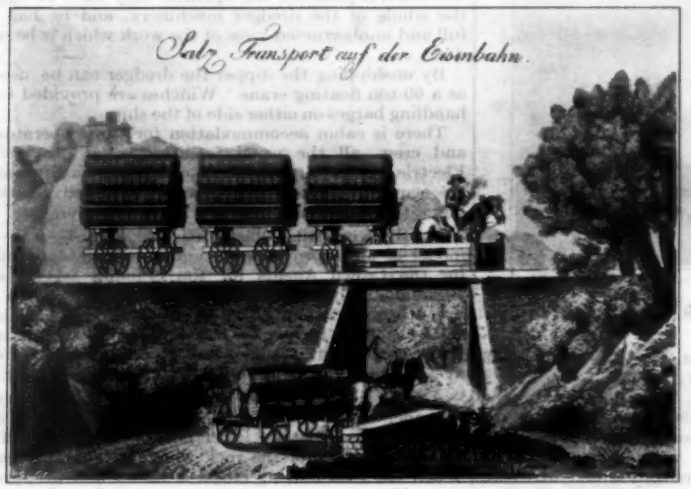
The stations were very primitive buildings, and included a waiting room, where passengers had to register their names and addresses and show their passports to the civil or military authorities half an hour before the departure of the train. The other buildings furnished very simple quarters for the employees, stabling for from 30 to 70 horses, and saddlery, wagon and blacksmiths' shops. One passenger and one or two goods trains were run daily, in large or small sections, according to traffic requirements. Each section was drawn by one horse, or sometimes two, harnessed tandem fashion. Passenger trains did the whole journey of 129 kiloms. in fourteen hours, the goods trains took three and a-half days. Eight hundred horses were employed in the service. Experiments were made with oxen in the beginning but proved a failure.

In 1834 the railway carried 2379 passengers and 30,000 tons of merchandise, and in 1860 28,000 passengers and 62,000 tons of merchandise. Passenger fares were 4d. per kilometre second-class, and 2½d. third-class. Goods rates averaged from 1s. to 1s. 6d. per 100 kilos. per kilometre. Gross revenues in 1860 amounted to about £47,000, of which 5 per cent. was from passengers and 95 per cent. from goods traffic. Operating expenses were £38,000, half of which was expended on horses, £1500 on rolling stock and materials, and only £800 on wages. The original capital was a million florins—£83,000—which was afterwards increased to £375,000. At first the railway barely paid its way, but, later, dividends were paid, ranging from 2 to 6 per cent. The last passenger train was run on December 2nd, 1872.

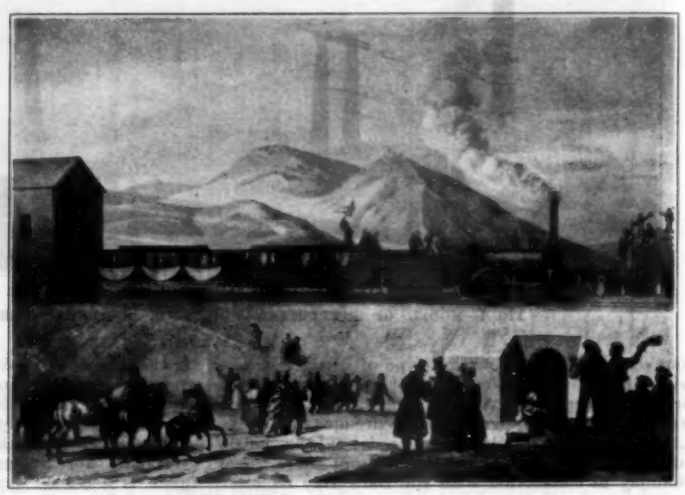
The first steam railway in Austria was the Kaiser Fredinands Nordbahn from Vienna to Bochnia in Galacia, a distance of nearly 466 kiloms. The first section of the line to be opened was from Vienna—Florisdorf, on the other side of the Danube—to Wagram, 15 kiloms., on November 14th, 1837.

In those early days a railway journey was no light undertaking. If the head of a family did not actually make his will before starting on his journey, at least he arranged all his most urgent affairs. The instructions issued by the railway authorities rather tended to increase popular anxiety. Passengers were solemnly warned against stretching their legs under the opposite seats, or otherwise impeding the free movement of their limbs, lest a sudden change in the speed of the train might throw them violently backwards or forwards. Similarly they were warned not to hold umbrellas or sticks in front of them, and particularly not to rest their heads or chins on such. Tickets had to be bought the day before, and the passengers were required to be at the station three hours before the departure of the train as the passport formalities usually occupied at least two hours.

It is interesting to note that the first engine drivers on this line were Englishmen, but their services were not required for any great period, as Austrians were soon able to take their places.



TRANSPORTING SALT ON THE LINZ-BUDWEIS RAILWAY



FIRST TRIP ON THE VIENNA-FLORISDORF-WAGRAM RAILWAY

THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—The Council of the Institution of Heating and Ventilating Engineers is enabled to offer the following prizes for original papers on subjects connected with heating and ventilating during 1925:—Lumby Premium, £10 10s.; Sirocco Premium, £10 10s.; Grenville Premium, £5 5s. The winning of an award carries with it a medal of the Institution. The prizes will be awarded as follows:—The Lumby Premium for the best paper submitted dealing with, or any subject connected with heating or hot water supplies; the Sirocco Premium for the best paper submitted dealing with ventilation and the general application of fans, air washing, air conditioning, dust and fume removal, mechanical draughts, &c.; the Grenville Premium for the next best paper on any subject included in the above.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—The following is the programme of Friday evening discourses as so far arranged for the forthcoming before-Easter session:—January 16th, Sir William Bragg, K.B.E., F.R.S., Fullerian Professor of Chemistry, "The Investigation of the Properties of Thin Films by means of X-rays"; January 23rd, Dr. Arthur W. Crossley, F.R.S., Director, British Cotton Industry Research Association, "Science and the Cotton Industry"; January 30th, Dr. John W. Gregor F.R.S., Professor of Geology, University of Glasgow, "The Mountain Structure and Geographical Relations of South-Eastern Asia"; February 6th, Dr. R. W. Chambers, Professor of English, University College, London, "The Earliest Recorded Kings of the English"; February 13th, to be announced later; February 20th, Professor T. H. Pear, Professor of Psychology, University of Manchester, "Acquiring Muscular Skill"; February 27th, Dr. J. C. Irvine, F.R.S., Principal and Vice-chancellor of the University of St. Andrews, "Sugars from the Standpoint of the Organic Chemist"; March 6th, Mr. W. B. Hardy, F.R.S., Secretary of the Royal Society, subject to be announced later; March 13th, Dr. Gilbert Murray, Regius Professor of Greek, University of Oxford, "The Beginnings of the Science of Language"; March 20th, Dr. J. W. McBain, F.R.S., Professor of Physical Chemistry, University of Bristol, "Soaps and the Theory of Colloids"; March 27th, Sir Ernest Rutherford, F.R.S., Professor of Natural Philosophy, R.I., and Cavendish Professor of Experimental Physics, University of Cambridge, "Studies of Atomic Nuclei"; April 3rd, Sir Daniel Hall, F.R.S., Chief Scientific Adviser and Director-General of Intelligence Department, Ministry of Agriculture, "The Productivity of English Land."

Railway Matters.

THE Minister of Transport has recently made the West Hartlepool Light Railways (Amendment) Order, 1924, conferring further powers upon the Corporation of West Hartlepool with regard to the light railways authorised by the West Hartlepool Light Railways Orders, 1897 to 1913.

THE excellent suggestion is made by the *Railway Age* (New York) that the year 1930 should be devoted to the railway centennial in America, and that the Railway Congress be invited to go there that year. It has been pointed out that an invitation to visit Madrid that year has been accepted, but there is, of course, much more to learn in America.

SPEAKING recently at Marseilles, M. Daladier, Minister of the Colonies, said that he was at present considering a scheme which was to be submitted to Parliament for the further development of the French Colonies. It was proposed to ask the Chamber and Senate for a credit of fifty million francs per year for ten years. That sum would provide for the construction of from 8000 kiloms. to 9000 kiloms. of railways, which would enable colonial products to be brought down to the sea coast, whence they could be shipped to France.

THE accident at Minshull Vernon, near Crewe, on Friday evening last, wherein a motor car was struck by the 4.8 p.m. from Carlisle and three of the occupants killed, draws attention to the fact that the accident occurred at an accommodation crossing. Such facilities have to be provided by a railway company when its line passes through property, in order that the owner of the latter may get from one part of it to the other. The railway company's responsibility ends at that, and all movements across the railway are made at the occupier's own risk. At public road crossings, on the other hand, the gates have to be protected by and interlocked with signals, and a gatekeeper has to be provided, who must open and shut them.

EXTENSIVE schemes of improvements and reconstruction have been put in hand or are about to be embarked upon by the Great Western Railway on the Devon and Cornwall sections of its line. The locomotive shops at Newton Abbot are to be extended, and the engineering depôt at Plymouth rearranged. Paignton Station is to be reconstructed in order to deal with the increasing volume of passenger traffic. The St. Thomas Viaduct at Exeter is to be renewed, a new masonry viaduct constructed to replace the existing timber bridge at Perran on the Falmouth line, Penwithers Viaduct at Truro is being replaced by an embankment, and the stone bridge over the Laira Old-road at Plymouth is to give way to a steel girder structure with a 60ft. span. The Newquay branch line is to be extended from Blackwater Junction to Chacewater, and a number of new road motors is to be added to the service in the two counties.

IN order that the crews of their engines may have more comfortable quarters when stranded away from home, the London, Midland and Scottish Railway has decided to build at Camden Town a hostel containing 90 bedrooms for the accommodation of engine-drivers, firemen and guards. For some time it has been felt that the lot of these men, whose life is necessarily irregular owing to the nature of their work, should be ameliorated as far as possible. Arrangements made to deal with the problem had been gradually outgrown by increasing traffic. The accommodation became out of date and insufficient, and the alternatives for the overflow were outside lodging houses or long journeys to another hostel. Reading, dining and recreation rooms will be provided in the new "engine-driver's hotel," which is to have central heating throughout, and one apartment will be specially reserved as a drying room for the men's clothes in bad weather. In addition to the luxury of a hot bath when coming off duty, the guests will have at their disposal an up-to-date laundry.

THE Ministry of Transport railway statistics for August, recently issued as a Stationery Office publication, show that, compared with the corresponding month of 1923, 4,361,150 more passengers were carried at reduced fares, but those at full fares were 2,867,139 less in number. The net increase was 1.3 per cent. and the receipts showed an increase of 4.9 per cent. This increase in number and the increase of 4.9 per cent. in the receipts were secured by 0.7 per cent. more passenger train mileage. The freight returns were less satisfactory. The tonnage was 4.8 per cent. less, which, it is explained, was probably due to the falling off in the export of coal—the tonnage of coal and coke was 8.6 per cent. less. Freight train receipts were down by 1.3 per cent., which is the more significant—though not mentioned in the official statement—by the fact that the rates in August last were on the reduced level whi h came into operation in August, 1923. Freight train miles were, however, 3.2 per cent. less, and the trains were better loaded—an average of 128¼ tons, instead of 125¼ tons—and got over the road better—442¼ ton-miles per engine hour instead of 438¾.

THE *London Gazette* announces that Lieut.-Colonel Sir Herbert A. Hacken has been appointed to command the Engineer and Railway Staff Corps, Royal Engineers, Territorial Army, and has been promoted to the rank of Colonel. In Article II., on September 20th, 1918, of our series "British Railways under War Conditions," the origin of the Staff Corps was explained. The leader of the movement for its establishment was Charles Manby, the late James Forrest's predecessor in the secretaryship to the Institution of Civil Engineers, who had been inspired by the establishment on November 16th, 1859, of the National Volunteer Association and the Wimbledon meeting the following May. The Corps was constituted in January, 1865, and Colonel McMurdo, who in 1860 had been made Inspector-General of Volunteers, was its first Colonel. Its purpose was, and is, to provide a body of officers and men connected with railways who will be able to serve as part of the Territorial Army in the operation of railways. Quite good work used to be done by bodies of officers and men, *e.g.*, at Crewe, some years ago, but interest therein was lost when the Corps fell more under the administration of the military authorities and less under the railway officers. The value of such a corps has now again been recognised, and railwaymen are encouraged to join.

Notes and Memoranda.

IT is said that the supply of natural gas in Canada is diminishing so rapidly that it is necessary to take serious measures for its conservation.

EXPERIMENTS with a new process for producing flax yarn are to be made with a quantity of flax straw which is being sent to this country by the Saskatchewan provincial authorities, under agreement with the Canadian Trade Commissioner at Glasgow.

IT appears from an article by Mr. A. C. Broughton in the *Industrial Australian*, that Australia possesses some of the richest radium deposits of the world. The deposits are in the Mount Painter district, in the northern part of South Australia, and the ores are said to be worth £900 a ton for their radium and uranium contents. At the foothills there are some springs having a temperature of 90 deg. Cent.

THE power station which is to be constructed in connection with the electrification of the Cape Town Suburban Railways is to have a capacity of 30,000 kilowatts in three units. The turbines will be by Howden, the alternators by the English Electric Company, the condensing plant by Mirrlees, and the boilers by Babcocks. The sets will run at 3000 revolutions per minute, and generate 12,000-volt, three-phase current at 50 cycles.

SOME experiments made in America, which are described in the *Engineering News-Record*, indicate that the best means of preventing subsoil water rising into roadways is the use of a layer of sand in the foundations. It is suggested that the merit of the sand is probably due to the fact that the particles are large enough to prevent capillary action, while the interstices are not sufficiently large to allow the fine capillary material to enter and act as a wick to pass the moisture through the layer.

ONE of the most forcible arguments against the further diversion of water from the Great Lakes, up the Chicago River, was recently put forward by the Detroit City Council, when it said that it strenuously protested "against the abstraction of lake waters at Chicago as being unnecessary for sanitation requirements of that city, a great injury to the commerce of the Great Lakes, and an unwarranted invasion upon the rights of the several States and provinces bordering upon the waters named."

THE two 30in. diameter steel cables which will carry the Philadelphia–Camden Bridge across the Delaware will require 25,100 miles of wire. Each of the cables is 3550ft. long, weighs 3500 tons—practically a ton per linear foot—and is formed of 61 strands of 306 wires each, or a total of 37,332 individual wires—0.195 in diameter—for the two cables. While designed to resist a pull of 36,700,000 lb., each cable, according to the results of tests already made, will have an actual tensile strength of 115,000,000 lb.

WHEN the Victorian Rivers and Water Supply Commission has completed the Sugarloaf, Wimmera and Maffre water storages, the total capacity of the State storages will exceed 1,264,000 acre-feet. At present the total under the commission's jurisdiction approximates 813,500 acre-feet, as compared with Victoria's total of 172,000 acre-feet twenty-two years ago. The Hume Reservoir will contain at least 1,100,000 acre-feet, half of which can, subject to the provisions of the river Murray agreement, be credited to Victoria's storages controlled by the Rivers and Water Supply Commission.

IN order to meet the unusual difficulties of conducting building operations in winter, the contractors in charge of the erection of the Chateau Lake Louise at Banff, for the Canadian Pacific Railway Company, have been obliged, says the *Contract Record*, to adopt novel methods. As the hotel is situated at the highest point on the railway's line through the Canadian Rockies, where the temperature may reach 20 deg. to 50 deg. below zero, workmen could not endure the extreme cold. The hotel will therefore be built within a wooden shell, which will be made comparatively air-tight, and will be extended upwards as each additional storey is completed. The walls of the shell will be 6ft. from the outside walls of the chateau, and provision is to be made for temporary heating. In order to have the building completed for next summer's business, 350 men are being employed.

THE circumstances attending the explosion last March of a water-tube boiler at the power station of the British Insulated and Helsby Cables, Limited, Prescot, are dealt with by Mr. J. F. Blenkinsop in a report on his preliminary inquiry. He states that the explosion was due to accumulation of scale on the inside of the tubes, the tube which failed having become overheated and weakened, and so was unable to withstand the pressure to which it was subjected. On account of heavy calls for power and light, the thorough inspection of this particular boiler was deferred for two months. About 12.5 per cent. of the feed water is obtained from a deep bore-hole well, and the inspector states that as a result of using this water, scale had deposited on the inside of the tubes and other heating surfaces, varying in thickness from $^1/_{16}$in. to $^5/_{16}$in. The question of fitting a water-softening plant was put before the company, and this plant, now in course of erection, will reduce the incrustation on the heating surfaces.

TESTS and analyses to determine the effect of several impurities on the occurrence of redshortness in wrought ferrous metals have recently been made by the American Bureau of Standards. The tests were made on electrolytic iron and on "commercially pure iron." It was concluded that:—(1) Sulphur is the principal element responsible for redshortness and should not exceed 0.01 per cent.; (2) so long as the sulphur is low, oxygen is not harmful in amounts up to 0.20 per cent.; (3) manganese may prevent the harmful effect of sulphur, provided the manganese amounts to three times the sulphur and provided the oxygen does not exceed 0.04 per cent.; (4) manganese is less efficient when oxygen is high, say, 0.10 per cent. or higher; (5) copper in amounts up to 0.5 per cent. has little tendency to produce redshortness, and in some of the specimens tested it tended to decrease the redshortness. No noticeable change was observed in any of the strength properties of soft steel—rivet steel—with variation of sulphur percentage up to 0.17 per cent.

Miscellanea.

IT is reported that some further important discoveries of alluvial platinum have been made in the Transvaal.

THE first of the trackless trams which extend the Rotherham system to Maltby, was run on December 14th.

THE Darlington Town Council is proposing to substitute trolley omnibuses for the present system of electric trams.

IT is expected that the sugar and motor spirit factory which is being erected at Sulekere, Mysore, will be ready for work in February.

IT is reported that the Remington Typewriter Company, of New York, has made arrangements for the building of a plant in Toronto, starting next spring.

IT is proposed to construct a bridge over the Richmond River, New South Wales, at Ballina-street, Lismore, at a cost between £35,000 and £40,000.

A POWER station, worked by steam, of 400,000 horsepower capacity, is to be put up at Avon, Ohio. The cost, according to *Power*, will be 30,000,000 dollars.

AN expedition fitted out by the Russian Geological Committee reports important discoveries of coal in the neighbourhood of the river Kocyn in the Petchora region.

IT is suggested by the *South African Mining and Engineering Journal* that a Gold Mining Congress and Exhibition, held in Johannesburg, would be both timely and beneficial.

THE municipalities of Uitenhage, Cradock and Maritzburg, South Africa, are all contemplating extensions to their water supply schemes. The total proposed expenditure is some £300,000.

IT is intended to sink the new shafts of the Londonderry Colliery, at Seaham Harbour, Ireland, by means of the freezing process, as the measures through which they will pierce are mostly water-bearing.

THE Spalding Rural Council has decided to be included in the electricity order at present being prepared by the Spalding Urban Council. The suggestion that the rural area should be included in the order came from the Urban Council, and the Rural Council, whilst assenting, has decided to ask for the inclusion of certain clauses protecting their own powers of supply.

THE scheme for supplying electricity in West Wiltshire by the West Wilts. Electric Light and Power Company is, it seems, progressing well. The company, which is to be incorporated with a capital of £25,000, is to absorb undertakings in Trowbridge, Melksham and Chippenham, and will supply in villages in the area wherever the demand so warrants. Energy will be supplied in bulk by the Bath Corporation.

THE production of pig iron in November amounted to 583,500 tons, compared with 586,400 tons in October, a slightly higher daily rate. The furnaces in blast at the end of the month numbered 173, an increase of two since the beginning of the month, four furnaces having been blown in and two damped down or blown out. The production includes 197,500 tons of hematite, 178,800 tons of basic, 150,300 tons of foundry, and 31,700 tons of forge pig iron. The output of steel ingots and castings amounted to 672,800 tons, compared with 678,500 tons in October and 645,000 tons in September.

WHAT is said to be the largest order for high-tension switchgear and transformers ever placed in this country has recently been secured by the Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester. It comprises the 132,000-volt switchgear and transformers for the new Witbank generating station and Brakpan distribution station of the Victoria Falls and Transvaal Power Company, Limited. The value of the order is approximately a quarter of a million pounds. The operating line voltage of 132,000 volts is the highest yet undertaken for power transformers by British manufacturers.

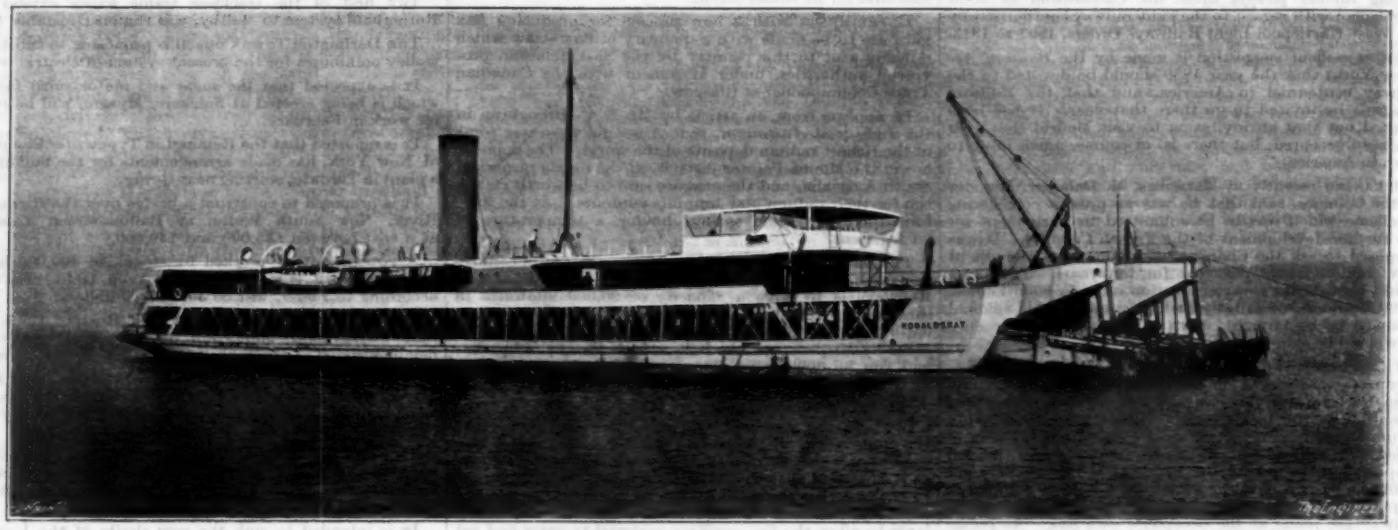
AN old fire-grate associated with Newcomen came under the auctioneer's hammer at Dartmouth, where Newcomen was born in 1663 on Thursday of last week. Although of such historical interest to the town, the town councillor who was present at the auction only bid 5s., and the relic was secured by a private buyer for 37s. 6d. The grate had been incorporated in a house which the late Mr. Thomas Lidstone, the county surveyor, built on Ridge Hill, Dartmouth, in 1868, and named Newcomen Cottage, because it contained a good deal of material which its owner had retrieved when Newcomen's house in Lower-street, was demolished.

AT a recent meeting of the informal section of the Institution of Electrical Engineers, Mr. G. M. Clark delivered a lecture entitled "A Walk Round Pretoria Power Station." The Pretoria electricity works, the lecturer explained, was a splendid example of the way difficulties of transport and of labour could be overcome in the more remote places of the earth. The new site and its surroundings were municipal property, and civic pride seemed to have influenced the policy governing the improvements Mr. Clark described. A comprehensive schedule of figures showed some remarkably good results and also some enviable efficiencies, but Mr. Clark stated that a 40 per cent. load factor was by no means uncommon in South African towns. A very low-grade coal, costing 1s. 6d. per ton at pit-head, was carted 80 miles at a cost of 6s. 9d. per short ton.

IN connection with the proposal to build a new bridge over the Hooghly at Howrah, the Committee of the Bengal Chamber of Commerce suggests that steps be taken to obtain estimates of the cost of the three types of bridge. These are: (1) The cantilever proposed by the Committee of Engineers in 1922; (2) the twin floating bridge, as proposed by Sir Bradford Leslie; and (3) an improved bridge, with improved approaches, of the type of the existing bridge, as recommended by the Committee of Engineers in 1912. The estimate in respect of each of these would require to show separately—(*a*) the cost of the bridge; (*b*) the cost of the approaches; and (*c*) the amount of compensation claimed by parties suffering loss from the new bridge. In addition, it would be necessary to give the time required for construction, and also the annual maintenance charges, plus interest and sinking fund.

THREE RECENTLY-BUILT BRITISH DREDGERS

(*For description see page 695*)



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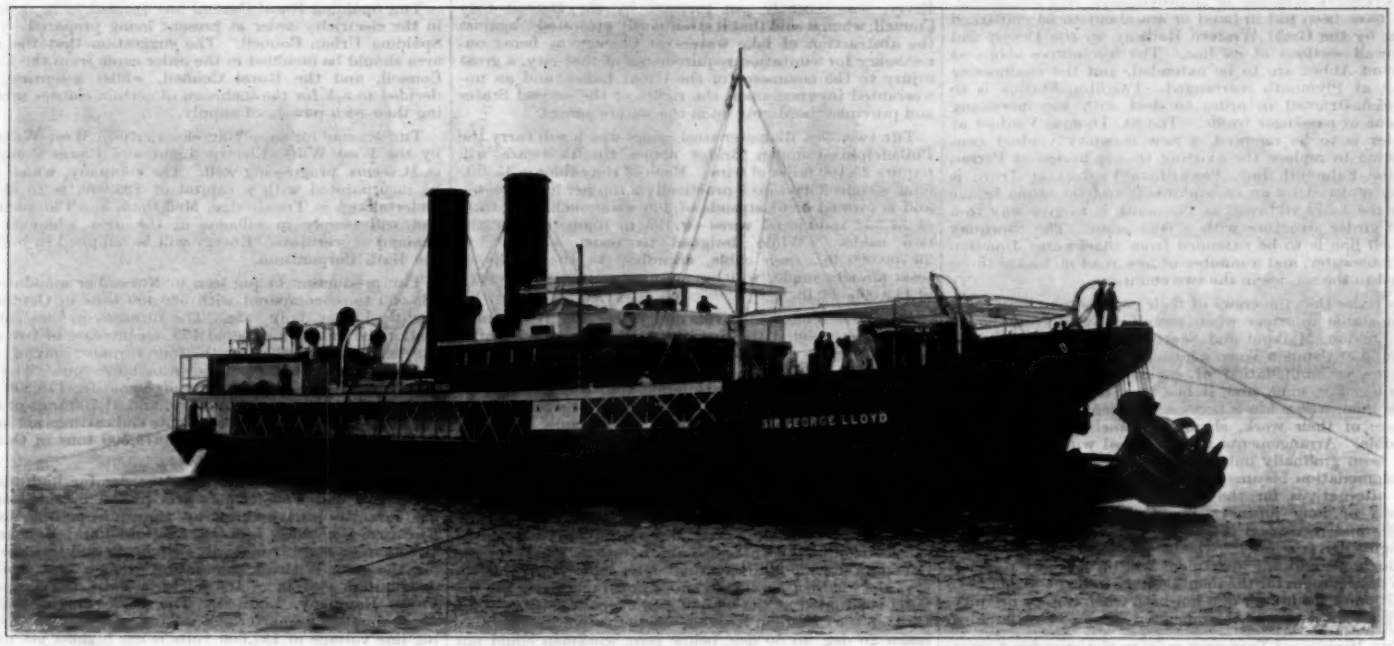

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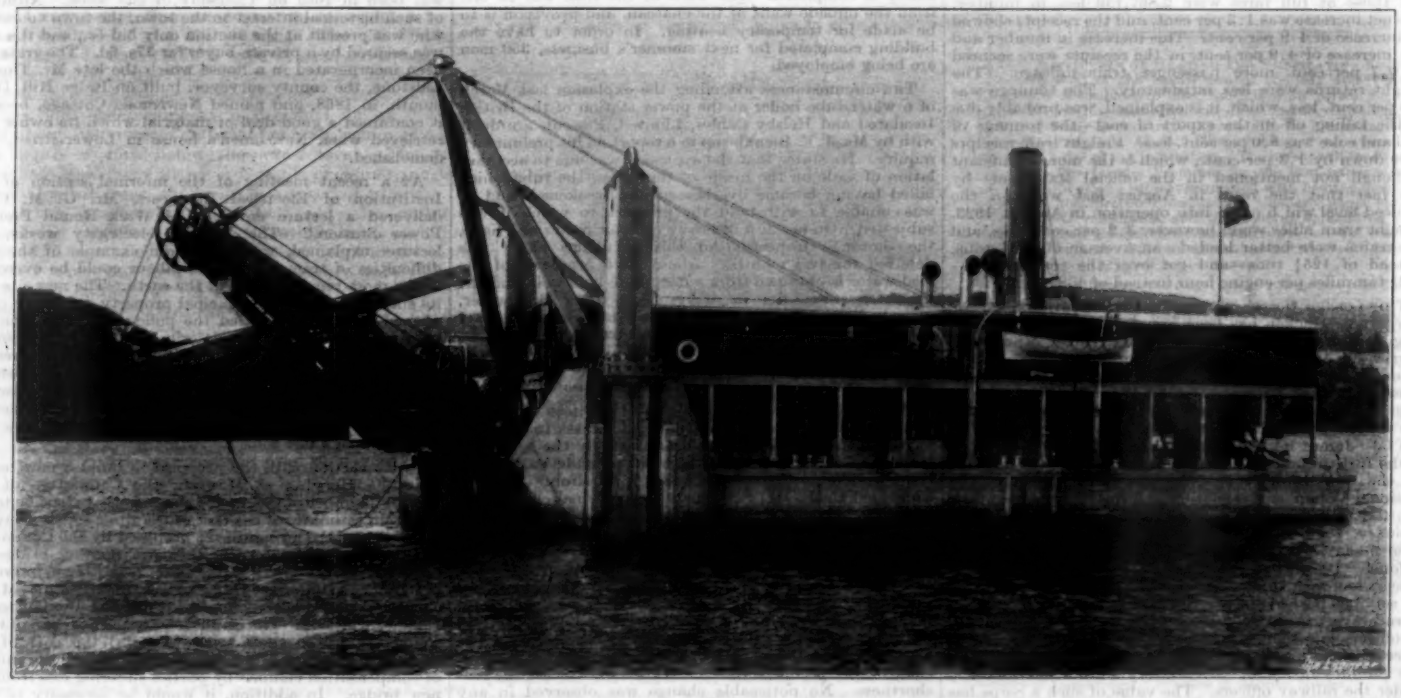

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DEATH.

ON December 10th, at Spring Bank, Smallshaw, Ashton-under-Lyne, MARTIN LUTHER HALL, J.P., managing director of Joshua Heap and Co., Limited, in his sixty-eighth year.

Editorial Announcement.

THE RAILWAY CENTENARY, 1825-1925.

In preparation for the Railway Centenary, which will be celebrated in the coming year, a new history of the steam locomotive in Great Britain will appear in serial form in the pages of THE ENGINEER, *beginning on January 2nd, 1925. It has been written by Mr. E. L. Ahrons, and as all recent researches have been carefully scrutinised, it may be safely described as the most accurate history of locomotives which has ever been compiled. It will, of course, be fully illustrated, and it is unnecessary to say to readers of* THE ENGINEER *who are well acquainted with Mr. Ahrons' work, that it will be as interesting as accurate.*

THE ENGINEER.

DECEMBER 19, 1924.

The Carnot and Rankine Cycles.

As a means of estimating the ideal maximum thermal efficiency of a heat engine working between given temperature limits, the Carnot cycle has for a generation and more been universally accepted as strictly just in the abstract, but as too rigidly perfect for practice. The first three stages of the cycle are more or less satisfactorily included in the operation of a steam engine, but the fourth, the adiabatic compression of the working fluid back to the upper temperature limit, is absent. The Rankine cycle represents an attempt to bring the fourth stage into reasonable agreement with practice. It differs from the Carnot cycle only in so far that the working fluid during the fourth stage is raised from the lower to the upper limit of temperature, not by adiabatic compression, but by a process involving the taking in of heat at all temperatures between the two limits. Recent developments in steam engineering, specifically the practices of "bleeding" steam from turbines—for the purpose of feed heating—and of re-heating the steam after its original superheat has disappeared from it, have introduced some difficulty and ambiguity into the application of the Rankine cycle as originally defined. The Committee on Heat Engine and Boiler Trials, it will be observed from a report appearing elsewhere in this issue, now proposes to recast the definition, and include in it an allowance for bleeding and re-heating. At the meeting on Thursday, December 11th, when the proposed modification was debated, the subject was handled on a high theoretical plane, but little being said about its practical bearing. Yet it has, or so it seems to us, an important and fundamental practical aspect, which deserves expression. The Carnot cycle is so abstract, so unmistakably removed from what can be effected or realised in practice, that there is no remote likelihood of its wholly ideal nature being misunderstood. The Rankine and the modified Rankine cycles, on the other hand, owe their origin to a desire for a standard exhibiting improved conformity with practice. There would therefore seem to be some possibility that, without sufficient examination, the true worth of either of the latter as a practical guide may be exaggerated. In this respect, it is illuminating to study Captain Sankey's illustrations of the results given by the different cycles in a number of selected cases. It will be found, we think, that on the whole the original Carnot cycle gives a better reflection—accidentally, no doubt—of the known advantages of certain practices in steam engineering than the modified cycles. It would, in fact, almost seem to be established that the more we attempt to bring the standard cycle into agreement with practice, the less becomes the value of the cycle as a practical guide.

A non-condensing engine using saturated steam at 120 lb. absolute and exhausting at atmospheric pressure, has an ideal thermal efficiency of 16 per cent., according to Carnot, and of 15.07 per cent. according to Rankine. If the steam be superheated by 100 deg. Fah., the ideal thermal efficiencies become 25.32 and 15.36 per cent. respectively. Two features of these figures should be noted. In the first place, the Rankine cycle gives to the simple primitive non-condensing low-pressure engine, using saturated steam, a thermal efficiency only slightly less than that prescribed by the Carnot cycle. Secondly, the adoption of superheating, according to the Rankine cycle, results only in a minute increase of efficiency, a rise of 0.3 in the percentage figure, while the Carnot cycle figure shows an increase amounting to 9.3. Let us improve the engine by adding a condenser to it, the admission pressure being unaltered, and the back pressure becoming 0.5 lb. absolute. With saturated steam, both cycles indicate a considerable increase of efficiency, the Carnot figure being 32.67 per cent. and the Rankine 29.47. As before, let the steam be superheated by 100 deg. Fah. According to Carnot, the ideal efficiency is advanced to 40.15 per cent. According to Rankine, it becomes 29.78. It is again to be noted that the Rankine cycle ascribes but a minute improvement to superheating, while the Carnot cycle shows it to be relatively large. It should also be noticed that the improvement of the engine by the adoption of a condenser has widened the difference between the Carnot figure and that given by the "more practical" Rankine cycle. Let us advance a stage further in the improvement of the engine by raising the admission pressure to 250 lb., the back pressure being, as before, 0.5 lb. With saturated steam the Carnot efficiency becomes 37.37 and the Rankine 33.01 per cent. If we superheat the steam by 160 deg. Fah. the figures are respectively 47.19 and 33.7 per cent. By doubling, or thereabouts, the pressure we have, according to both cycles, gained something, but the gain shown by the Carnot cycle is greater than that given by the Rankine. The gap between the figures has, in fact, become greater. As regards the value of superheating, the Rankine figures again imply but a minute improvement, whereas Carnot shows it as before to be considerable. Even if we carried the superheating to the high figure of 700 deg. Fah. total temperature, the Rankine cycle would fail to indicate any considerable gain, the figure for the efficiency in this case being 34.8—an advance of merely 1.8 on the saturated state. The Carnot figure, on the other hand, would show an advance of over 16, namely, to 53.51. Let us once more improve the engine by again doubling the admission pressure. With saturated steam at 500 lb. and a back pressure of 0.5, the Carnot efficiency becomes 41.91 and the Rankine 36.25 per cent. If the steam is superheated by 240 deg. Fah., the figures are 53.85 and 37.56. Once again the gap has widened, and once again Rankine fails to indicate any material improvement in the efficiency by the adoption of superheating. Let us now consider other modern methods of improving the working

of steam engines by returning to the case of the condensing engine using steam at 250 lb. If the steam is superheated by 160 deg. the Carnot and Rankine figures are, as stated above, 47.19 and 33.7 per cent. Let us improve the engine by adopting the principle of re-heating. The superheated steam is, we will suppose, expanded to 100 lb. pressure, and then re-heated by 100 deg. Fah. Thereafter it is expanded to 50 lb. pressure, and again re-heated by 100 deg. Fah. Finally, it is expanded to the back pressure. The Carnot cycle being concerned only with the initial and final temperatures of the working fluid, takes no account of the intermediate heatings. It leaves the efficiency unaltered at 47.19 per cent. Here, then, is an ideal opportunity for the "more practical" Rankine cycle—in the Committee's modified form—to show its superiority over its older rival, which for once has been caught napping. Actually, however, it succeeds in advancing the ideal efficiency from 33.7 only to 33.97 per cent. Let us cut out the re-heating process and substitute for it bleeding and feed heating, after the manner prescribed in the Committee's definition. The Carnot cycle again fails to take account of anything except the initial and final temperatures, and leaves the efficiency still at 47.19 per cent. The modified Rankine cycle justifies its existence by raising the efficiency from 33.7 to 37.88. In this instance, the newer cycle is clearly a better practical guide than the older. But if we consider the case of combined re-heating and feed-heating, peculiarities again become apparent. For the 500 lb. pressure condensing engine, using steam superheated to 240 deg., and employing the feed-heating principle, the Carnot and modified Rankine figures are respectively 53.85 and 42.91 per cent. Let one stage of re-heating from the saturation point back to a superheat of 240 deg. be introduced. The Carnot figure remains at 53.85; the Rankine figure behaves even worse, for it falls to 42.69. The Rankine cycle, it will be seen, accords to superheating an advantage so small that in practice it would not be given a second thought. It is no more kind to re-heating and may pronounce definitely against the combination of re-heating with feed heating. It recognises the value of a condenser, and somewhat mildly commends the use of high pressures and of feed heating when unaccompanied by re-heating. The Carnot cycle emphasises the value of superheating and indicates a clear gain by the adoption of a condenser and of the use of increased boiler pressures. It refuses to pronounce judgment on the value of re-heating and feed heating, alone or together.

Such, in brief, is the record of these cycles, as revealed by an examination of Captain Sankey's illustrative figures. Are they such as to inspire confidence in any one of the three cycles as a practical guide to the value of a suggested improvement in the operation of steam engines? On the whole, the Carnot cycle seems least dangerous in this respect, least likely to be misleading. With its indifference to the nature and properties of the working substance, its postulation of a method of working which bears little resemblance anywhere to the manner of operation of an actual engine, its wholly theoretical character can never be mistaken. The Rankine cycle, on the contrary, is definitely associated with the properties of steam, as set forth in the steam tables, its stages are adjusted to correspond in principle with the stages through which the steam passes in an actual engine, and the separate organs in which it presupposes the steam to pass through these stages have all got counterparts in practical engines. It appears to be much more realistic than the Carnot cycle, and for that reason it may be regarded by some as a sounder practical guide. In reality, it is just as theoretical, and, as the figures we have quoted definitely show, it can be a good deal more misleading. Were the Rankine cycle a satisfactory criterion of practical developments, it ought with each improvement to show a nearer and nearer approach to the abstract, indisputable, un-doctored maximum of the Carnot cycle. Actually, the reverse holds good. The simpler and more primitive the conditions of working, the closer is the agreement between the two values. It may be said that an improvement of the academical thermal efficiency is not the sole, or even the principal object in view when superheating, re-heating, and so on, are adopted. It may be argued that the value of these processes in practice is primarily measured by factors other than the thermal efficiency, the sole quantity with which the Carnot and Rankine cycles are concerned. This view confirms rather than detracts from our argument. If either cycle is so conspicuously one-sided as to reflect only a single minor object sought in, or secured by, practical improvements, its claim to our attention as a practical guide becomes painfully thin.

Marking Time.

If there was one lesson more striking than any other to be learnt from our bitter experiences during the Great War, it was surely the overwhelming importance of applying scientific knowledge and methods to the purposes of warfare in all its branches. When the stress came upon us, and we were in a death grapple with an enemy who not only had at his service every device of modern science, but also the skill and knowledge to utilise them to the full, we found ourselves, as a nation, appealing to our men of science for help. That help was freely and splendidly given, but under conditions which, at the outset and indeed for a considerable time were so adverse as to make the efforts all but hopeless. It is true that we did "muddle through," and at the end, when we had breathed our first sighs of relief, we raised the cry of "never again." Now, after six years, it is pertinent to ask whether that cry has been forgotten or whether all is being done that could and should be done to keep our fighting Services in an entirely efficient state so far as the knowledge and use of modern scientific methods are concerned. We do not in any sense advocate militarism, nor the unnecessary expenditure of a penny on preparedness for war, but "preparedness" is a word of wide meanings, and there is one kind of preparedness which we do most strongly advocate, and that is preparedness of knowledge and equipment. It is not a matter of piling up munitions, building ships or guns or aircraft, which may well become obsolete at an unexpectedly rapid rate, but preparedness of knowledge, and the question we would raise is whether in that sense our fighting services are not tending to drift back into a position relatively as inferior as it was in 1914.

It is true, of course, that a good deal of effort is being devoted to research in many directions. Progress in those branches of research which are mainly of industrial interest is being encouraged and assisted, to a certain extent, by Government efforts, while the services themselves are doing a certain amount of work in those directions which they have selected as most directly important for their purposes. The lessons of the war are being exploited in this work and new developments along the lines which proved important in 1914-1918 are being pursued. Explosives and poison gases, aircraft and submarines are all receiving as much attention as reduced staffs and closely restricted expenditure will allow. It is not, however, these directly military or naval matters that our criticism touches, but rather the idea that lies behind the present attitude of our Service Departments to the question of research in general. With limited means at their disposal, it is not unnatural that they should tend to confine their attention strictly to questions which appear to those in control to bear most immediately upon Service requirements. But is that enough? The progress of research is so rapid and the possibilities of the application of its results to fighting purposes so wide, that it is not humanly possible for men engaged upon actual work in the fighting Services to form a sound opinion as to the effect of current scientific developments upon the fighting methods of the future. Yet to-day, more than ever before, it is that which counts or rather will count heavily and decisively whenever the test of another war comes upon us. Happily, the prospects of such a disastrous event are remote for the moment, and, we hope, for many years to come. That, however, is all the stronger reason for taking extremely long views in these matters. It is not so much the fighting machines of to-day or to-morrow that matter, as the ability to make and use and meet the fighting machines of the day after to-morrow. Unhappily, such a policy of long views is lacking in our fighting Services to-day. No doubt shortness of funds is to some extent responsible, but shortness of views is a more serious factor. The attitude often encountered is that if any particular problem which is put forward for study does not offer direct and immediate prospects of advantage to the Service concerned, then that Service will take no interest in it. The existing materials of engineering, for instance, are considered to be adequate for the present needs of the Services; investigations which are bound to lead to the development of newer and better materials are regarded as essentially of industrial interest. Yet, in case of war, it is the fighting Services which would call upon science and industry to furnish something better than the present best in order to enable them to meet the superior products which research has meanwhile developed in other countries. The matter, however, goes much deeper than any question of materials, although it may be serious enough in regard to them. A revolutionary scientific discovery may at any time bear within it the germ of a revolutionary development in the mechanism of war, and from this point of view those responsible for our national safety are deeply concerned with the progress of even the most purely scientific research. The present Service attitude is like that of the industrialist who awaits developments elsewhere in the hope of profiting by them afterwards, and is disinclined to provide financial support for the abstruse kind of work which so often leads to startling developments, simply because he does not see how work of that kind can be of advantage to him.

In advancing this criticism of the current Service attitude towards research, we do not forget that the field of possible scientific research is so vast, and the possibilities of development so numerous, that it would scarcely be feasible for our Services to interest themselves in all and to afford them all financial support. But in practice the matter is rather different; the number of competent, first-rate research workers is limited, and the services of the best of them are at the disposal of the nation at a relatively very modest cost. It is these men who are the best fitted to judge what are the directions for fruitful research, and it is by their advice that the fighting Services should be guided. Actually, the decision as to what work is to be done or left undone lies in the hands of a few Boards or Committees, largely composed of men of high technical attainments, who, however, have little personal understanding of the nature, meaning and possibilities of research, but tend to look upon all such matters from the technical aspect of the present needs of their own particular branch of work. As a result, we see researches on vehicle road springs, on wireless direction finding, and similar matters whose direct practical importance is clear and obvious, liberally encouraged. The deeper and wider questions, however, are "not the business of the Services." That attitude might be harmless or even wise, if we could be sure that these more fundamental kinds of research received adequate support and encouragement on behalf of the nation, to whom they are vital, from some other source. Unfortunately, such support is only forthcoming in totally inadequate measure, and with grudging slowness, unless some direct industrial interest can be invoked. The danger is not perhaps immediate, and we may even be saved in the long run by the splendid voluntary efforts of enthusiastic men of science who carry on their work with little encouragement and still less actual reward. None the less, it is a serious matter that our Services should, in this respect, be content to sit still and await the fruit that may fall into their laps. We may easily, in the future, once again find ourselves opposed by scientific methods which our fighting Services have neglected, and witness the terrible spectacle of the sacrifice of inadequately protected lives while we struggle to make good, as best we can, the omissions of the past. We have no desire to see research organised solely or even mainly for the development of engines of destruction. Rather would we emphasise that research can only proceed successfully upon its own natural lines, but that these, at frequent intervals, touch upon the needs of the fighting Services, and that in many cases those Services themselves cannot guess to-day the ful extent and nature of the needs of even a few years hence.

Literature.

Brassey's Naval and Shipping Annual, 1925. Edited by Sir Alexander Richardson and Archibald Hurd. Wm. Clowes and Sons. 25s. net.

The new volume of "Brassey" is not inconveniently large or heavy, yet in its six hundred odd pages every question of immediate importance to the maritime world is dealt with at adequate length. It is arranged in the form with which we have now grown familiar, though its division into Naval and Merchant Shipping sections is of comparatively recent date. The editors have again shown excellent judgment in their choice of contributors. Commander C. N. Robinson, R.N., first and ablest of naval critics, is responsible for chronicling British naval developments during the year. He brings under review such outstanding events as the world cruise of the Special Service Squadron, the postponement of the Singapore scheme, the Fleet review at Spithead, and the transfer of our principal squadrons to the Mediterranean; but in

view of the Admiralty's desire for reticence, he is unable to present many facts about new construction. Foreign naval progress is surveyed by Lieut.-Commander A. Colquhoun Bell, R.N., and the editors contribute their usual chapter on comparative strengths, taking occasion to rebut statements to the effect that a new rivalry in light naval construction has grown out of the battleship limitation compact. Of the many other excellent papers in this section, that on "Light Cruisers," from the pen of Sir George Thurston, is of quite exceptional interest. Sir George brings his practical knowledge of warship design to bear on the problem of our future cruising ships, the dimensions and armament of which are restricted by Treaty. Having enumerated the essential requirements of the type, he submits alternative designs for a vessel of 10,000 tons. By accepting the three-gun mounting, we might have nine 8in. guns, a speed of 35 knots, and a certain amount of protection to vital parts. If two-gun turrets are held to be preferable, only eight guns could be carried, and half a knot must come off the speed. In yet another plan, nine guns and 34 knots are offered at the sacrifice of some armour. In every case a powerful anti-aircraft armament is provided, together with a uniform equipment of twelve 24in. torpedo tubes. It will be interesting to learn in due course which of these three designs corresponds most nearly to that of our new "County" type.

Cruisers also furnish the theme of two other papers, Captain Delpierre, of the French Navy, explaining why, in his judgment, France is ill-advised to go in for their construction on the present large scale; whilst Captain D. Knox, U.S. Navy, treats of the political aspect of current cruiser programmes in what impresses us as a rather partisan spirit. In "The Navy and its Fleet Air Arm," an anonymous writer draws up a restrained but formidable indictment of the system which denies the Navy control over its aviation service. We believe, and have always believed, this system to be contrary to the national interest, and, we might add, to common sense. Aircraft have already become as integral a component of the Fleet as submarines; they have a definite function to perform in all problems of naval strategy and tactics, and yet they and their *personnel* are withdrawn from Admiralty control. When the country realises how naval air training is being hampered, we may hope to see an end put to a system which only endures because of public apathy. Admiral A. P. Niblack, U.S. Navy, reveals some of the less obvious motives of American naval policy; while Commander C. H. N. James, R.N., examines the relation of naval bases to fighting power, thus touching on a question which the Government's resolve to proceed with the Singapore works has invested with special interest. In his chapter on a well-balanced fleet, Captain E. Altham, R.N., discusses the present composition of our naval forces. He approves the maintenance of separate fleets in the Atlantic and Mediterranean, but would prefer to see them brought under the supreme command of one flag officer. "The existing policy of two entirely separate commands tends to produce different systems of training, different doctrines in matters of tactics and even of strategy, and different standards of efficiency." This section concludes with an article by Commander Robinson on the advantages of the naval career, which may be read with profit by the parents of would-be naval officers.

In the Merchant Shipping Section there is a number of papers which will appeal to engineering readers. Sir Westcott Abell contributes an admirable summary of the world's shipping and shipbuilding position. It is distinctly comforting to learn on such high authority that the outlook, gloomy enough at present, may become brighter in the not too remote future, though improvement is made conditional on industrial peace. Mr. James Richardson, whose papers on current progress in marine machinery are always instructive, is concerned chiefly with the internal combustion engine, which is steadily gaining in favour among shipowners. It is a fact not generally realised that of the world's tonnage under construction to-day over one-third is represented by motor ships. In Germany and the Scandinavian states more motor ships are being built than steamers. While the oil motor is no longer open to criticism on the score of reliability, there still remains the drawback of high initial cost, and how to reduce that cost is the problem of immediate importance. Mr. Richardson thinks it may be solved by increasing the heat quantity in the cylinder, and therefore the power per ton weight of machinery, rather than by cutting down the scantlings which have been standardised as the result of long experience and numerous material failures. Summing up, he writes: "Competition between the great builders of internal combustion machinery the world over will be extraordinarily keen for some time to come, and provided British marine engineers receive sufficient encouragement from the shipowner there would appear to be no fear whatsoever of falling behind technically in the race. Technical developments on a broad scale at home are in train which should go far to ensure continuance of our position, and may even lead to a definite advance." Among other papers of professional interest in this section are those on shallow-draught vessels for inland navigation, the equipment of merchant ships, and results of direction finding by wireless.

There are the usual lists of British and foreign war vessels, with plans and profiles of the more important types; many pages of silhouettes of merchant ships, and the statistical and documentary appendices which are so useful for purposes of reference. The illustrations are both plentiful and artistic. The whole volume bears witness to the zeal and industry of the editors, who are worthily upholding the high traditions of this famous annual.

Cotton Cellulose: Its Chemistry and Technology. By A. J. HALL, B.Sc., F.I.C. London: Ernest Benn, Limited. Price 30s. net.

To a man with experience in the cotton trade this book is of unusual interest as putting things of importance together in a thoroughly systematic way without giving preference to any particular issue and still without missing essentials. It is a book readable by the expert as well as the tyro, and it is suited to its modest frame most admirably—as it is not intended to replace the great number of detailed text-books already in existence, but to define and outline the great questions appertaining to a great industry. The phraseology is commendably simple and unaffected, and should suit the mainly technical reader well.

A start is made with the growing of cotton and the production of raw cotton. Tables are given of the various kinds of cotton, named after the places of production, a very welcome innovation, especially as lengths of staple, colour, appearance, &c. &c., are given for the various kinds. Then follows the chemical aspect of the purification of raw cotton and the nature of the various substances removed. A description of a high-pressure kier is a modern addition to this chapter. An American method of preparing standard cotton is described, which in practice must be rather risky, as the apparatus has a glass beaker for boiling 3 litres of solution for hours at a time! One would hardly expect such a method to come into general use with such glass as is obtainable to-day.

The chapter on cotton and alkalis is unusually complete and full of details and useful tables. In treatment this chapter is practical, and no application of modern colloid chemistry is attempted. One might perhaps have liked to have seen some more prominence given to the purely physical side of the question, *e.g.*, the osmotic phenomena amongst others. Shrinkage, tensile strength, gloss, &c., are treated in connection with mercerisation with and without tension. The comparatively great indifference of cotton to alkalies is pointed out, and the reviewer never remembers having seen such a full and useful *résumé* of modern work on the subject in a text-book.

Then follows a chapter on the behaviour of cotton towards acids, which is also treated well, though not so exhaustively as the previous one. This is a matter of necessity, as cotton is a highly reactive substance, which C. F. Cross pointed out, much to the astonishment of the chemical world, which looked upon cellulose as one of the most indifferent of organic compounds up till thirty years ago. The author has included the discussion of a number of fatty acids, of which acetic acid is the most important one, as the product is used for artificial silk. Reading through the chapter with special knowledge of any silk process, one may certainly find fault with recipes and lack of detail with regard to temperature, probably the most important factor predetermining the viscosity of the solutions of the cellulose derivatives. These facts are, however, kept as secrets from the public as yet.

The important Xanthate reaction—viscose—is also treated as well as the cupro-ammonium one, but the zinc chloride solutions are barely mentioned. This is a distinct fault, as the most economical production of artificial silk will no doubt evolve on that basis. Silk has been produced that way by Strehlenect, and the proof of the comparatively easy production of zinc-free filaments from zinc chloride solution is given by its universal use in making carbon filament incandescent electric lamps. It is strange that this particular solution is treated so badly in the chemical literature, even Cross and Bevan giving entirely erroneous information on the subject. One would have expected the author to have gone more deeply into that matter.

Chapters on the influence of light, stress and heat on cotton follows, that on fluorescence being of special interest. The parts referring to bleaching and dyeing are discussed on a novel plan and are worthy of special study.

Artificial silk is treated mainly with a view to show the behaviour of the various kinds towards dyes. Some kind of description of the production of the fibres with simultaneous spinning would have greatly enhanced the value of the book, as well as facts and figures relating to the influence of the viscosity of the solutions upon the quality of the products, especially as the title includes the technology of the subject. On page 195 there is a somewhat glaring misprint: "The denier is denoted by the weight of 9 metres of the silk expressed in grams," instead of 9000 metres. The general fault of artificial silk fibres, their brittleness, is hardly mentioned at all, though their tenderness towards wear is indicated. This subject is of great economic importance, and of great interest to Lancashire spinners as a possible outlet for waste cotton. It is quite interesting to note that the annual production of artificial silk is already 50 per cent. greater than that of natural silk!

The book finishes up with a chapter on select analytical methods.

In conclusion, the reviewer wishes to reiterate that this book is remarkably pleasant reading, and possesses an evenness of treatment and balance of chapters, which is very unusual in English text-books. It does not teach you everything about everything, but the essentials of most things appertaining to the subject in a way on which the author is to be congratulated.

SHORT NOTICES.

The Constituents of Coal Tar. By Percy Edwin Spielmann. London: Longmans, Green and Co. Price 12s. 6d. net.—This book is one of a series of monographs edited by Sir Edward Thorpe, who writes an appreciative introduction. It is written mainly for the organic chemist, to whom it ought to be welcome as re-assembling facts which are generally scattered in text-books on organic chemistry. An innovation is attempted, viz., not to mark degrees Centigrade with C., but that is not to be recommended, as with due deference to Sir Edward Thorpe the most highly scientific books also give degrees absolute. A graph facing page 47 gives percentages of toluene, benzene and xylene, obtained by distilling 200 cubic centimetres of the mixture and observing the boiling point of two fractions of the distillate. Barometric pressure is omitted, hence the approximation to the truth obtainable cannot be very great. The curves are continuous algebraically and could be easily integrated, as they approximate to parabolas. The bulk of the book is pure organic chemistry and demands special knowledge from the reader. The bibliography given at the end, a commendable practice from the point of view of the reader as well as the printer, and references are given by numbers in the text. Many new complexes are described and the work is thoroughly up to date.

Small Electric Generating Sets. By W. Wilson. London: Ernest Benn, Limited, 8, Bouverie-street, E.C. 4. Price 18s. net.—Many books have been written on small electrical installations, but the present volume deals with the subject more fully than usual. It is written on quite simple lines and it should be useful to those who are not electrical specialists. Those who are desirous of installing a small plant for lighting purposes and who cannot make up their minds what type of plant to employ will find the chapters on non-automatic and automatic sets a decided help. In these chapters the author describes a considerable number of modern petrol plants which have been put upon the market by different firms. The book is not, however, by any means purely descriptive. It contains a good deal of practical information in engines and dynamos, cut-outs, switchboards, &c.

Constructional Steel Work. By Harry Atkin. London: Chapman and Hall. 1924. Price 9s. 6d. net.—This is a volume in the D.U., or "Directly, Useful," technical series. It is not concerned at all with the theory or mathematics of steel structures, but wholly with the workshop processes and machines used in their manufacture. It covers in its chapter such subjects as the unloading and straightening of stock, marking off, riveting, the use of compressed air, smithing, assembling, and describes the principal machines employed in the manipulation of structural steel. From which it will be seen that it is rather a book for the yard manager and foreman than for the draughtsman.

Structural Engineers' Handbook. By Milo S. Ketchum. London: McGraw Hill Book Company. 1924. 35s.—The fact that this book is now in its third edition, although the first copy was issued only ten years ago, is some indication that it serves a useful purpose. It contains a great fund of information concerning the theoretical side of structural engineering—naturally, as it is viewed by American eyes. Some space is, however, devoted to the practical side of the art. The only criticism which we have to make is that some of the sections, such as those devoted to tables which can be found in any pocket-book, might be omitted with the idea of making room for a more comprehensive index.

Motor and Carriage Painting. By A. Bates. London: The Trade Papers Publishing Company. 1924. 6s.—This excellent little work is now in its second edition and has been enlarged by the addition of information on the most modern processes of coach painting. Reference is, for instance, made to the American system of "permanent wood filling," in which the foundation of the paint is actually incorporated in the surface texture of the wood and is not merely laid on the top of the face. All the operations for painting a car are dealt with, from removing old paint to applying monograms with gold leaf. The book is essentially practical and the author warns his readers of many pitfalls which might trap the beginner.

Kelvin Centenary Oration and Addresses Commemorative. London: Percy Lund, Humphries and Co., Limited. 1924. 6s. net.—On July 10th and 11th, 1924, the birth of Lord Kelvin on June 26th, 1824, was celebrated by a meeting at which Sir J. J. Thomson delivered an oration, and at which delegates from beyond the seas presented addresses, and by a banquet at which Lord Balfour took the chair, and at which Sir Richard Glazebrook, Dr. Elihu Thomson, Professor Luigi Lombardi, and Dr. A. E. Kennelly spoke. The oration, the congratulatory addresses, and the dinner speeches have all been collected in the volume before us—a volume which many will value in memory of a very great scientist and because it contains the illuminating oration of Sir J. J. Thomson and the delightful speech made by Lord Balfour at the Kelvin banquet.

Steam Extraction or Pass-out Steam Turbines.*

By W. S. BURGE and J. P. CHITTENDEN.

WHEN it is considered that, owing to the latent heat of steam, to produce saturated steam at 30 lb. pressure from feed water at 60 deg. Fah. requires 1136 B.Th.U. per lb., and that to raise this steam to 200 lb. saturated requires only the addition of 34 more B.Th.U., it is appreciated how wasteful it must be to raise steam in a factory separately for both heating purposes and for the generation of electrical power, because the saturated steam at 200 lb. pressure, if expanded down in a turbine to a pressure of 30 lb. for the factory, will give up no less than 145 B.Th.U. per lb. of steam before it reaches the required steam pressure, and these heat units, assuming a conversion efficiency of 65 per cent., will give 1 kilowatt for about every 36 lb. of steam passed out for process work.

If a hypothetical case is taken of a factory requiring, say, 50,000 lb. of steam per hour at 30 lb. per square inch, saturation temperature, and a boiler efficiency of 70 per cent., a feed-water temperature of 100 deg. Fah., and coal having a calorific value of 11,000 B.Th.U., then the actual evaporation will be 7 lb. of steam per lb. of coal, and the total coal per hour will work out to 3.19 tons. If, instead of generating the steam at 30 lb. per square inch gauge, the heat reception is continued until steam at 200 lb. pressure and a superheat of 200 deg. Fah. is obtained, and this steam is allowed to do useful work, while expanding down to the desired pressure of 30 lb. per square inch, then assuming the same feed-water temperature, boiler efficiency and heat value of coal, the actual evaporation per lb. of coal will be 6.2 lb. of steam, and the total coal consumption 3.6 tons, giving an increase in coal consumption of .41 ton, but for this extra increase of coal, we obtain a total heat release of 8,400,000 B.Th.U. from the 50,000 lb. of steam, and assuming a steam turbine efficiency as in the previous case, these heat units will produce 1600 kilowatts.

If the factory produces this 1600 kilowatts by means of an ordinary high-pressure turbine, exhausting at, say, 28in. vacuum, the steam and coal consumptions would, while maintaining the same efficiencies and boiler conditions as assumed previously, be as follows:—Steam consumption, 13.7 lb. per kilowatt, making a total steam quantity of 22,000 lb., and a coal consumption of 1.59 ton per hour.

It will therefore be seen that under similar boiler-house conditions, boiler and turbine efficiencies, the comparative results of the two cases are as follows:—

(*a*) If obtained separately, coal consumptions are:—

For electrical output	1.59 tons
For steam output	3.19 „
Making a total coal consumption of	4.78 „

(*b*) If obtained through a pass-out turbine, the coal consumptions are:—

For steam output	3.19 tons
Additional coal for electrical output	.41 „
Making a total coal consuption of	3.60 „

From the foregoing assumed conditions, it will be seen that a saving of about 24 per cent. in coal is obtained, so that in cases where electrical energy as well as low-pressure steam is required, a considerable saving can be effected.

To appreciate the design and conditions of working of a pass-out turbine, an ordinary Mollier diagram can be well employed.

Fig. 1 is a portion of a standard Mollier diagram, as generally used for steam turbine design. On the vertical scale are plotted B.Th.U., and on the horizontal scale entropy. It therefore follows that for any given pressure and temperature, all vertical lines are lines of adiabatic expansion, and all horizontal lines represent expansion at constant total heat, such as takes place when steam is throttled or "wire drawn." The lines running downward from right to left are lines of constant pressure, and the lines running downward from left to right are condition lines, those above the saturation point being for superheated steam and those below for steam containing water or "wetness."

Taking the case of an ordinary high-pressure turbine, and assuming that the steam enters the turbine at a certain pressure and temperature indicated by the point A on this chart, and is to be expanded down to a final pressure as indicated by the point B, then were it possible to obtain a turbine with 100 per cent. efficiency, the expansion would take place down the vertical line joining the points A and B. Such an efficiency, of course, is not attainable, so if we assume an efficiency of, say, 70 per cent., then 70 per cent. of the total heat units available between A and B will be utilised, and if a point is taken at C as representing the proportion of 70 to 100, and a horizontal line be drawn across to the point D, then the point at which this line cuts the line of constant exhaust pressure will represent the condition of the steam on leaving

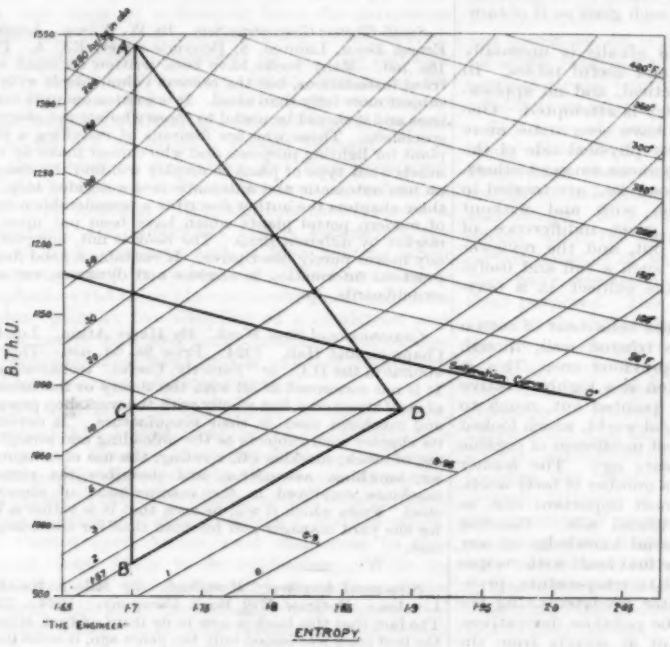


FIG. 1

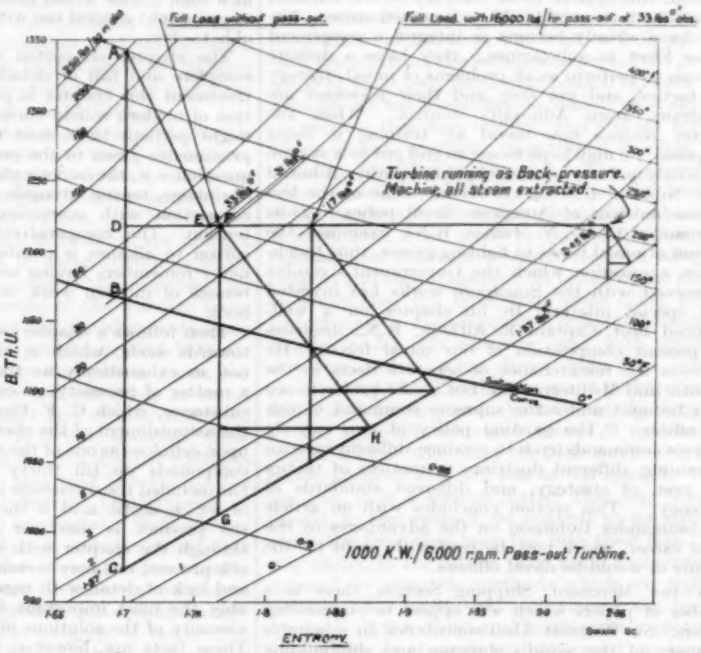


FIG. 2

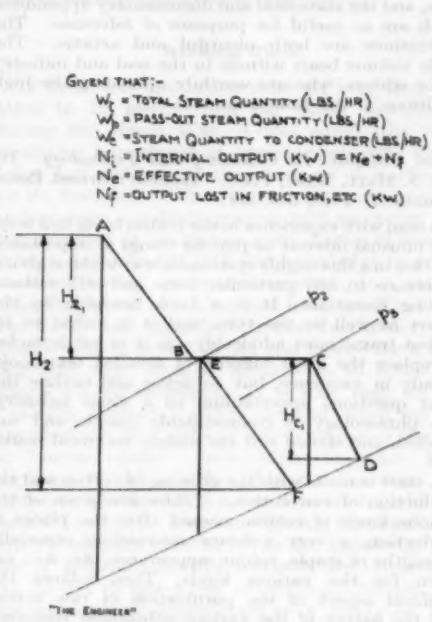


FIG. 3

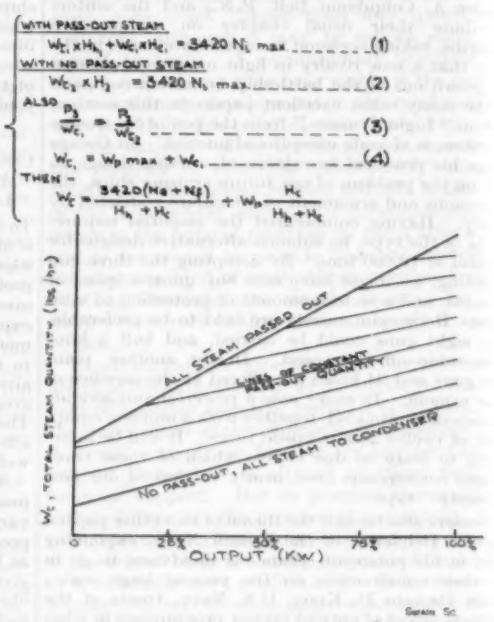

WITH PASS-OUT STEAM
$W_{t_1} \times H_1 + W_{c_1} \times H_{c_1} = 3420\ N_i$ max ..... (1)
WITH NO PASS-OUT STEAM
$W_{c_2} \times H_2 = 3420\ N_i$ max ..... (2)
ALSO
$\frac{P_3}{W_{c_1}} = \frac{P_3}{W_{c_2}}$ ..... (3)
$W_{c_1} = W_p$ max $+ W_{c_2}$ ..... (4)
THEN -
$W_t = \frac{3420(N_e + N_f)}{H_1 + H_c} + W_p \frac{H_c}{H_h + H_c}$
W_t = TOTAL STEAM QUANTITY (LBS/HR)
ALL STEAM PASSED OUT
LINE OF CONSTANT PASS-OUT QUANTITY
NO PASS-OUT, ALL STEAM TO CONDENSER
0
25%
50%
75%
100%
OUTPUT (KW)

FIG. 4

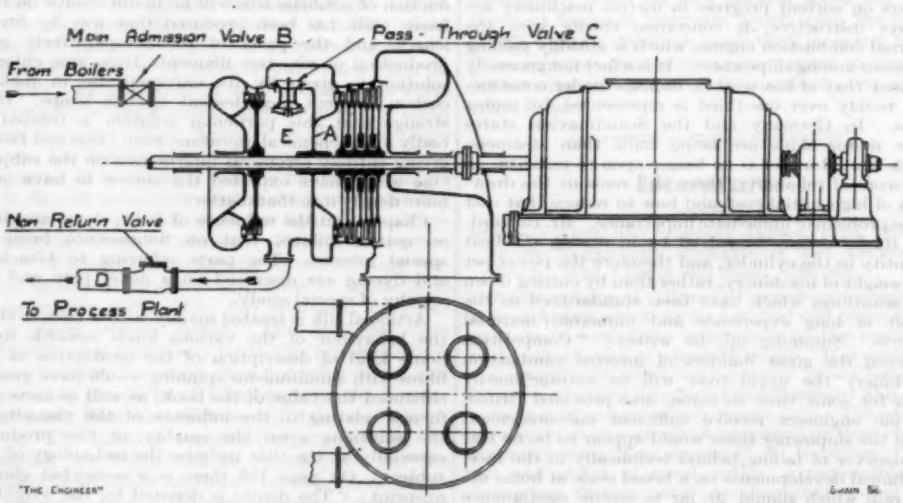


FIG. 5

* From a paper read at Manchester on November 20th before the North-Western Branch of the Institution of Mechanical Engineers.

the last row of blades in the turbine, and if the efficiency of 70 per cent. is constant throughout the machine, a line joining the points A and D will give the condition of the steam at all intermediate stages.

This gives a simple illustration of the use of the entropy chart for an ordinary high-pressure turbine, and the same can be equally well applied to a pass-out turbine, except that in this case the machine is divided into two distinct portions, which are diagrammatically illustrated in Fig. 5. It will be seen that all the steam is admitted to the turbine through the main admission valve B, a certain amount of useful work being done by the steam in the first portion of the turbine, and it is then either passed out for heating purposes through a branch, or is allowed to pass through the valve C to the remaining stages of the turbine and thence to the condenser.

On the Mollier chart—Fig. 2—the three principal conditions of working of a pass-out turbine have been indicated. In the first case, namely, at full load with all steam to the condenser, *i.e.*, working as a pure high-pressure condensing turbine, the steam enters the high-pressure portion at a pressure and temperature, as indicated at A, and is expanded through the various stages down to the desired pass-out pressure—in this case of 33 lb. per square inch absolute—and if the efficiency ratio of the high-pressure stage is in the proportions as indicated, then the condition of the steam leaving the high-pressure stage will be represented as at point E. The steam passing through the valve from the high-pressure to the low-pressure portion, will have a slight drop, which in this case has been taken as 2 lb., so that the steam entering the low-pressure portion will be at 31 lb. per square inch absolute, with a slight increase of superheat due to "throttling," as indicated at F. The steam is then expanded through the remaining stages of the machine, and with the efficiency as indicated, the pressure and condition of the steam after the last row of blades will be indicated at H.

If, however, at the same load the turbine passes out the full quantity of low-pressure steam—in this case taken as 16,000 lb. per hour—then more work will be done in the high-pressure portion and less steam will consequently pass through to the low-pressure portion, so that although the diagram remains the same for the high-pressure portion, there will be a greater amount of throttling across the pass-through valve and the pressure on the first stage will be in this case 17 lb. per square inch absolute, and the steam, although leaving the turbine at the same pressure, will contain less moisture.

The last condition to be considered is that of practically all steam being passed out, in which case all the work is done by the high-pressure portion of the turbine, only a very small amount of the steam passing through the low-pressure end and thence to the condenser. This small quantity of steam in this particular case is throttled to a pressure of 2.45 lb. per square inch, and on leaving the last stage it has been superheated to the extent of about 70 deg. Fah. It is here to be observed that a small amount of steam should be always passed through to the condenser, as otherwise there is a possibility of the windage of the idle running stages heating up the low-pressure end, but there is no necessity to make any special provision for this, as the amount of steam leaking through the diaphragm gland is sufficient for the purpose.

A skeleton outline of the method of obtaining the steam consumption curves for a pass-out turbine will now be given.

Fig. 3 shows the Mollier diagram for two main cases :—

(1) Maximum output with maximum quantity of pass-out steam, the expansion line being given by line A B C D.

(2) Maximum output with no pass-out steam, all steam flowing to the condenser, the expansion line then being represented by line A B E F.

Given that—

W_t = Total steam quantity (lb. per hour),
W_p = Pass-out steam quantity (lb. per hour),
W_c = Steam quantity to condenser (lb. per hour),
N_i = Internal output (kilowatts),

the following equations may be stated :—

With pass-out steam—

$$W_{t_1} \times H_{h_1} + W_{c_1} \times H_{c_1} = 3420\, N_i \text{ max.} \quad (1)$$

With no pass-out steam—

$$W_{t_2} \times H_2 = 3420\, N_i \text{ max.} \quad (2)$$

Also
$$\frac{P_3}{W_{c_1}} = \frac{P_2}{W_{t_2}} \quad (3)$$

$$W_{t_1} = W_p \text{ max.} + W_{c_1} \quad (4)$$

The maximum value of W_p is usually fixed. W_{t_2} is obtained from equation (2), and W_{t_1} and P_3 are obtained from (1) and (3) by trial and error, H_{c_1} being obtained when P_3 is known.

W_t can then be obtained from (1).

$$W_t = \frac{3420\,(N_e + N_f)}{H_h + H_c} + W_p \frac{H_c}{H_h + H_c}$$

$$N_e + N_f = N_i$$

where N_e = effective output ;

N_f = output lost in friction, &c.

These calculations being made for various values of W_p, give the consumption curves shown in Fig. 4. The lowest line represents the Willans line of the machine working as a pure condensing turbine, and the upper line working as a back-pressure turbine, all steam being passed out.

From the foregoing it will be obvious that the working of a pass-out turbine is primarily dependent on the control exercised by the main admission valve and the low-pressure or pass-through valve. An outline will therefore be given of how these valves must operate to fulfil the requirements of the pass-out turbine under actual running conditions. For this purpose reference may be made to Fig. 5.

It will be seen that the turbine is divided into a high-pressure section and a low-pressure, by means of a special blanking-off diaphragm indicated at A. The high-pressure steam supply is controlled by the main admission valve B, and the steam to the low-pressure section by the pass-through valve C. Pass-out steam is discharged through the branch D.

The main requirement of an extraction turbine from the point of view of process work is to maintain a constant pressure of pass-out steam, irrespective of the quantity required and the electrical load. It follows, therefore, that the pressure in the chamber E must be maintained independent of the relative proportions of the steam through the valve C and the extraction branch D.

Under any given condition of electrical load and pass-out quantity, the normal pass-out pressure will exist in the chamber E. Should, however, the demand for pass-out steam decrease, there will be a temporary and slight increase of pressure in the chamber E, and it will then be necessary for the valve C to open and admit an increased quantity of steam to the low-pressure stages of the machine. Assuming, however, that the electrical load has remained constant, this will have the effect of increasing the speed of the machine. The governor gear fitted to the machine must therefore be arranged to cause a readjustment of the main valve B and the pass-through valve C.

Conversely, an increase in the quantity of the extraction steam will be obtained at the temporary expense of the low-pressure section of the machine through the closing of the valve C. This must immediately be compensated for by the admission of more steam through the main valve B, followed by a further readjustment of the valve C, in order that the electrical load may be maintained. Under constant pass-out conditions, the admission of steam through the valves B and C will be purely dependent on the electrical load, but for concurrent variations of both the electrical load and the pass-out quantity, something in the nature of what may be termed a "see-saw" action must take place between the two valves.

The necessity of providing a definite means of automatically controlling the valves B and C under the various combinations of load and pass-out steam quantity which can occur will therefore be readily appreciated. With the usual types of control gear for pass-out turbines, a centrifugal governor is employed for controlling the speed and a pressure governor is provided for regulating the desired pressure of the pass-out steam.

The design and construction of centrifugal governors for steam turbines is well known, and consists of two balance weights, the centrifugal force of which, when rotated, is exactly compensated for by means of springs, thus giving a definite position of the governor for each variation in speed.

With regard to the pressure governor, this usually consists of a piston or diaphragm, one side of which is connected to the pressure in the chamber E, and on the other side this pressure is balanced by springs or weights, so that any variation of pressure in the chamber E causes the diaphragm or piston to take up a fresh position. It will therefore be seen that if by suitable means the centrifugal governor is connected to the admission valve B, and the pressure governor to the pass-through valve C, we can obtain the desired automatic operation of these two valves.

An example of mechanically interlocked gear is shown in Fig. 6, and represents the standard practice adopted by the English Electric Company for their pass-out steam

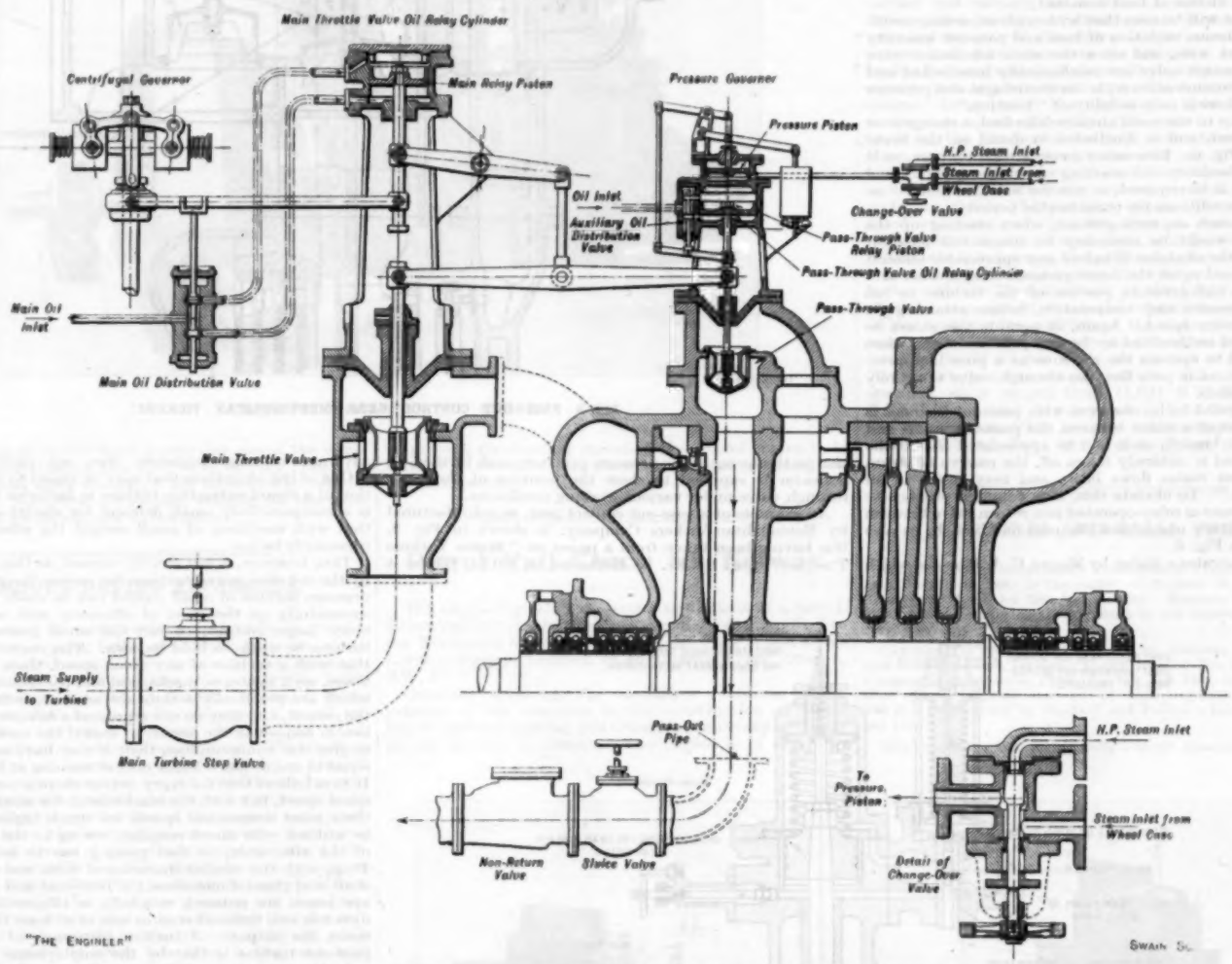


FIG. 6—MECHANICALLY INTERLOCKED CONTROL GEAR FOR PASS-OUT TURBINES—ENGLISH ELECTRIC

turbines. This type of gear removes any possibility of governor surging, and variation from the minimum to the maximum quantity of pass-out can take place without any change in the speed, variation in speed only taking place with change of load.

The operation of this gear may be explained as follows:—Considering an increase in load at a constant pass-out quantity, under such a condition the speed of the turbine decreases, causing the sleeve of the centrifugal governor to move upwards, operating the main oil distribution valve, thus admitting oil to the top of the main relay cylinder and opening the main admission valve. The resulting increase in steam pressure in the chamber E—Fig. 5—causes the pressure governor to operate the auxiliary oil distribution valve, which admits oil to the underside of the relay piston attached to the pass-through valve, thus reducing the pressure in the chamber E, and allowing more steam to enter the low-pressure stages of the turbine.

In the event of a decrease in electrical load, the closing of the main admission valve and the pass-through valve is effected by the reverse of this process.

Taking the second case, namely, a variation in pass-out quantity at constant load, a decrease in the demand for pass-out steam is accompanied by an increase in the steam pressure in the chamber E, which, acting on the underside of the pressure governor piston, causes the pass-through valve to open in the same way as already described. This has the effect of delivering an increased quantity of steam to the low-pressure stages of the turbine, until the pressure in the chamber E is again normal, the centrifugal governor controlling the speed of the turbine and thus keeping the electrical load constant.

Further, it will be seen that with such an arrangement, any simultaneous variation of load and pass-out quantity can be coped with, and since the main admission valve and pass-through valve are mechanically interlocked and in direct communication with the centrifugal and pressure governors, there is no possibility of "hunting."

In addition to the parts already described, a change over valve is fitted, and is illustrated in detail on the lower portion of Fig. 6. This valve serves a dual purpose, as it is used to facilitate the starting up of the turbine, and also, should it be required, to run the machine under "no pass-out" conditions for considerable periods.

Without such an arrangement, when starting up the machine it would be necessary to obtain full pass-out pressure in the chamber E before any appreciable amount of steam could enter the lower-pressure stages, thus subjecting the high-pressure portion of the turbine to full working pressure and temperature before attaining its normal running speed. Again, it permits the steam to pass free and unthrottled to the low-pressure stage, when it is desired to operate the machine as a pure high-pressure turbine, as it puts the pass-through valve C entirely out of operation.

Another point to be observed with pass-out turbines is the provision of a valve between the pass-out mains and the pass-out branch, as it will be appreciated that if the electrical load is suddenly taken off, the reserve of steam in the steam mains flows back, and may result in an "overspeed." To obviate this, it is common practice to place a pressure or relay-operated non-return valve between the low-pressure mains and the pass-out branch, as also indicated in Fig. 6.

Fig 7 illustrates a design by Messrs. C. A. Parsons, which is somewhat similar to the original A.E.G. construction, as the pressure and centrifugal governors are not interlocked. It differs, however, in the fact that in place of oil operation, steam is employed for working both the pressure governor and the servo motor controlling the pass-through valve, also the "leak-off" principle, as employed by Messrs. Brown, Boveri, has been adopted.

The pressure governor consists of a spring-loaded piston, the underside of which is connected to the pressure in the pass-out mains, and the servo motor piston is also spring-loaded. A predetermined and constant quantity of live steam is supplied to the underside of this servo motor piston, the pressure of which is regulated by the position of the leak-off valve attached to the pressure governor spindle. A means of regulating the pass-out steam pressure is obtained by adjusting the amount of initial compression on the spring of the pressure governor, and, further, an indicator is supplied to show the position of the pass-through valve under various working conditions.

An example of a pass-out control gear, as manufactured by Metropolitan-Vickers Company, is shown in Fig. 8, this having been taken from a paper on "Steam Turbine Practice" read by Mr. K. Baumann in 1912. Whilst it may not represent this company's latest practice, it is of interest in that it contains an additional valve, whereby the pass-out pressure can also be throttled. By this arrangement, the pressure in the chamber E can be raised, thus permitting an overload to be obtained automatically with small quantities of heating steam. It is further pointed out that this principle can be applied in such a manner that by always throttling the smaller quantities, either the low-pressure steam or the heating steam, higher economies can be obtained under other conditions of working.

Another means of obtaining similar results is by the employment of an arrangement, whereby certain stages of the low-pressure portion of the turbine can be by-passed, and although a higher average efficiency is obtained with such an arrangement, the further complication to the governor in most instances does not justify its use.

One of the objections that may be raised to the installation of a steam-extraction turbine in factories where there is a comparatively small demand for electrical power, is that with machines of small output the efficiency must necessarily be low.

This, however, is not strictly correct, as this can be met by the use of a geared turbine, for just as the geared high-pressure turbine of small output can be made to compete successfully on the score of efficiency with machines of much larger output, so can the small geared pass-out turbine be made to hold its own. The reason for this is that with a turbine of any given speed, there are certain losses, such as steam, mechanical and frictional losses, &c., which are practically a constant amount, independent of the output, i.e., they do not represent a definite percentage loss in respect to the ouput, so that if the speed is chosen to give the minimum loss, then it may have an efficiency equal to one of much larger output running at lower speed. It thus follows that for every output there is a most economical speed, but with the machines of the smaller outputs these most economical speeds are much higher than can be utilised with direct coupling, owing to the periodicity of the alternator, so that gearing has to be employed. Thus, with the smaller diameter of discs and consequent shaft and gland dimensions, the frictional and steam leakage losses are reduced, resulting in efficiencies equal to direct-driven turbo-alternator sets of at least three or four times the output. A further advantage of the geared pass-out turbine is that by the employment of suitable reduction gears a satisfactory direct-current generator can be installed, which enables a wide speed range to obtain on the electric drives in the factory.

It is difficult to define when a pass-out turbine should be installed, but it can be said that the range of adaptability of the steam turbine is so great that there are very few cases in which an instalment of an extraction type steam turbine would not show a direct saving where quantities of low-pressure steam are required for heating or other processes. In addition to this, the inherent advantages of the steam turbine are obtained, such as low maintenance and operation costs, saving in space with consequent reduction of foundations and buildings, and, finally, clean steam free from oil and other impurities for process work.

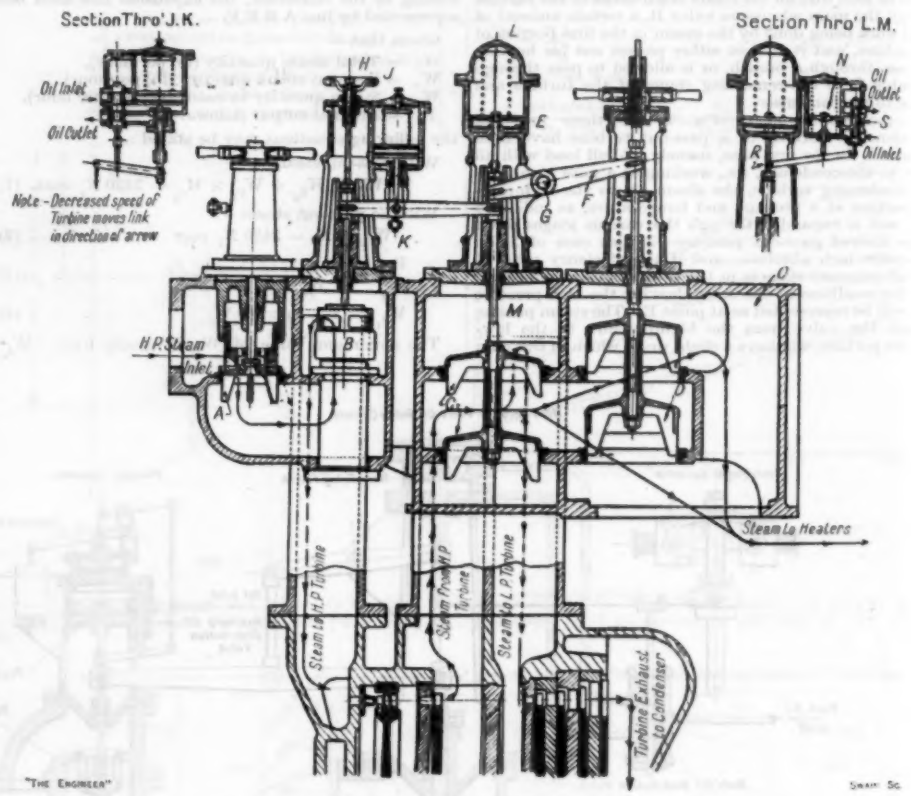


FIG. 8—PASS-OUT CONTROL GEAR—METROPOLITAN-VICKERS

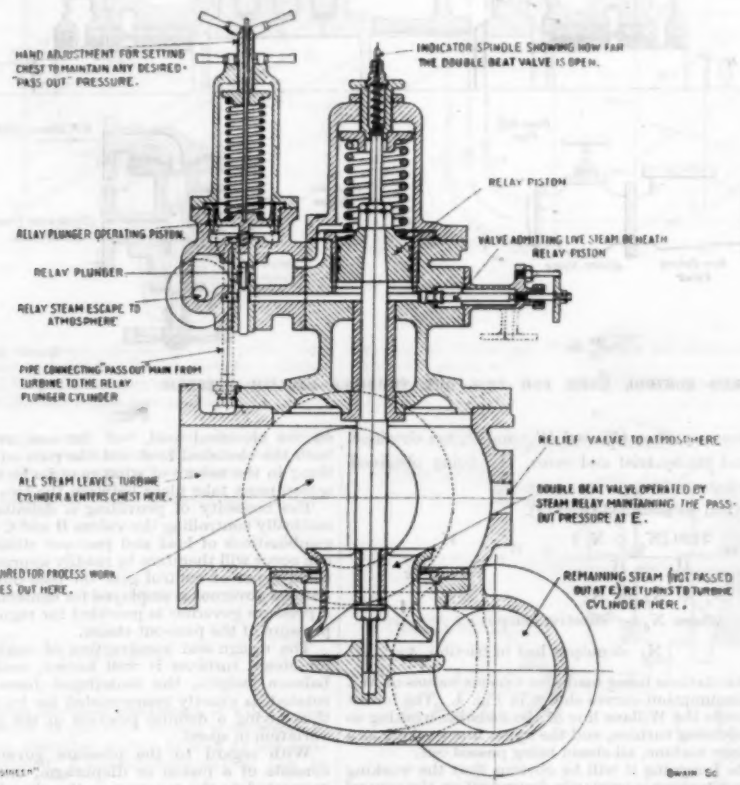
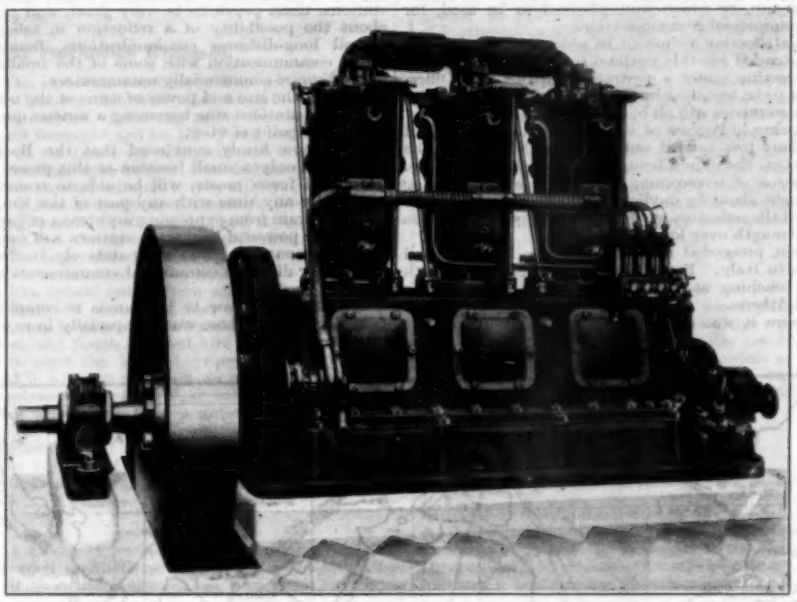

HAND ADJUSTMENT FOR SETTING CHEST TO MAINTAIN ANY DESIRED PASS OUT PRESSURE.
INDICATOR SPINDLE SHOWING HOW FAR THE DOUBLE SEAT VALVE IS OPEN.
RELAY PISTON
RELAY PLUNGER OPERATING PISTON.
VALVE ADMITTING LIVE STEAM BENEATH RELAY PISTON
RELAY PLUNGER
RELAY STEAM ESCAPE TO ATMOSPHERE
PIPE CONNECTING PASS OUT MAIN FROM TURBINE TO THE RELAY PLUNGER CYLINDER
RELIEF VALVE TO ATMOSPHERE
ALL STEAM LEAVES TURBINE CYLINDER & ENTERS CHEST HERE.
DOUBLE SEAT VALVE OPERATED BY STEAM RELAY MAINTAINING THE PASS-OUT PRESSURE AT E.
STEAM REQUIRED FOR PROCESS WORK PASSES OUT HERE.
REMAINING STEAM (NOT PASSED OUT AT E) RETURNS TO TURBINE CYLINDER HERE.
"THE ENGINEER"
SWAIN SC.

FIG. 7—PASS-OUT CONTROL GEAR—PARSONS

A report issued by the Engineering Committee of the Food Investigation Board deals with the first series of measurements made by Dr. E. Griffiths, at the National Physical Laboratory, of the heat conductivities of some of the heat insulators used in the construction of refrigerating stores. Dr. Griffiths finds that the heat conductivities of good dry cork, slagwool, charcoal and wood fibres at ordinary cold stores temperatures are all about 0.00011 C.G.S. units. Different brands of the same material differ to some extent in conductivity, and some of the materials at present used for heat insulation are liable to deterioration in situations where they may be subjected to heat or vibrations. In one case the conductivity had increased 40 per cent. Of the 17 materials tested, one—expanded rubber—appears to be little known as a heat insulator although its heat conductivity is about the same as that of cork.

Cold Starting Oil Engine.

Too late for inclusion in our issue of last week, we received from Ruston and Hornsby, Limited, of Lincoln, the photograph from which the accompanying engraving has been prepared. It represents a three-cylinder vertical cold-starting oil engine, which had not before been exhibited at the Smithfield Club Show, and was on that firm's stand in the Agricultural Hall. The engine is of 50 brake horse-power and will run on the cheapest fuels obtainable, such as crude, residual or tar oils. The makers say that the fuel consumption does not exceed 0.44 lb. per brake horse-power per hour in the smaller sizes, while it is as low as 0.42 lb. for the larger engines. Every set is tested to 10 per cent. above its rated power before it leaves the makers' works. These engines are made in



RUSTON COLD STARTING OIL ENGINE

sizes ranging up to 825 horse-power and one of the larger units was illustrated in THE ENGINEER of July 11th. On the same stand there was also a 16½ horse-power medium compression horizontal oil engine, working on the four-stroke cycle, which was new to the Show.

A MOULD DRYING APPARATUS.

AN apparatus for such services as drying out moulds in the foundry, heating ladles and similar purposes, which has already gained considerable favour on the Continent, has recently been introduced into this country by International Processes, Limited, of Basildon House, 7, Moorgate, London, E.C. 2. It really comprises a small gas producer, described as a "heating element," in which coke is burned with a bottom draught only. The products of combustion are drawn through the fire by a draught created by a compressed air ejector, and the air brought in by this ejector is preheated by a coil surrounding the furnace, so that the combustion of the gases is completed. The outlet from the heating element points downwards and delivers a stream of gas, which is said to have a temperature of about 2600 deg. Fah. when coke is being burned.

The idea is that this hot gas should be projected into the mould through the usual gate opening and thus drive out all moisture in the sand. It is claimed that the skin on the mould is improved by this process of drying, while the fuel consumed is much less than is the case with ordinary foundry practice.

GAS BLOWING ENGINE PERFORMANCE.

A STRIKING illustration of the reliability of the modern large gas engine of the horizontal slow-speed type has recently been offered by the results attained at the gas power station of the Barrow Hæmatite Steel Company, Limited. In this station there are six large gas engines, five of which were built by Galloways, Limited, Manchester. These engines are of the tandem horizontal double-acting four-cycle type, with gas cylinders 1150 mm. diameter, 1300 mm. stroke. Two of them, running at 94 revolutions per minute, are driving 1250 kilowatt direct-current generators. Three are coupled to blowing cylinders for supplying air to blast-furnaces, and, running at 85 revolutions per minute, develop 1650 brake horse-power. The gas used is blast-furnace gas, cleaned by the Halberg-Beth process.

We are informed by Galloways, Limited, that one of the blowing engines was recently opened up for examination after being in service without overhaul or internal inspection for no less than 77 weeks. Immediately prior to being stopped the engine was required to run at the low speed of 25 revolutions per minute, in itself a good test for gas cylinders, and did so satisfactorily. At the end of this long period of working its efficiency was in no way impaired, and examination revealed no evidence of any defects. All piston rings were intact and only one of the twelve rings in the gas cylinders was fixed in its groove, and that one only for one-third of its circumference. The wear of the rings was carefully measured, and only six out of the twelve required renewal.

The surfaces of the liners in both cylinders were in perfect condition, with a skin-like glass. The wear was very slight. The wear on the piston-rods also was very little, and the piston-rod packings required only cleaning before re-assembling. Carbon deposit on all parts was quite small, and the valves were in good condition and not very dirty. The working parts of the engine required only a very little attention in the form of slight adjustment of the bearings.

Seventy-seven weeks is an unusually long period of unbroken service for a gas engine, and the excellent state of the engine after this long run is ample testimony to the reliability of large engines of this type when well constructed and run in a well managed station. Another of the blowing engines at the works of the Barrow Hæmatite Steel Company had run for 75 weeks at the time the one above referred to was examined. In view of the condition of the engine examined, however, it was decided to prolong the running period of the second engine. In spite of its 75 weeks' run, therefore, it is not yet being laid off for inspection.

Petrol Rail Coach for Norway.

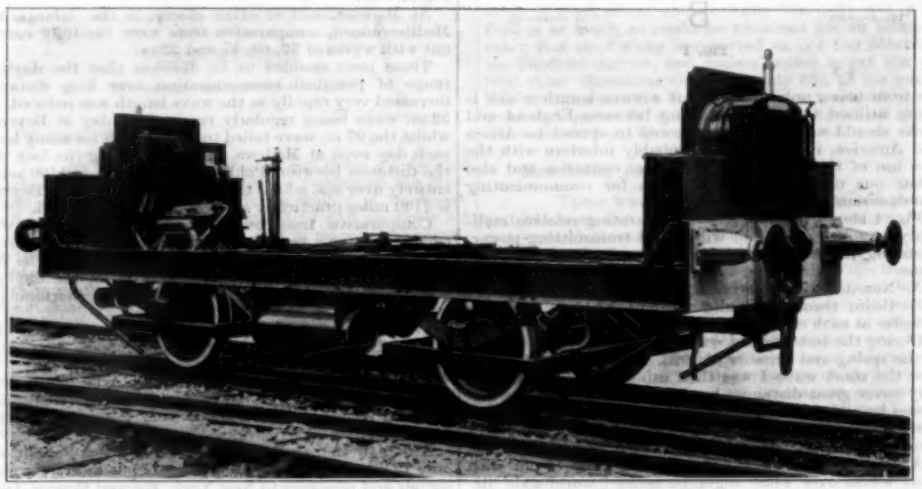
THE engraving below illustrates the chassis of a petrol-driven railway coach which has recently been supplied to the Norwegian State Railways by the Four Wheel Drive Lorry Company, Limited, of 46, Charing Cross, London, S.W. 1.

Generally speaking, the machinery conforms to the practice of the company in the construction of motor lorries, but the framing and wheels are naturally arranged to suit railway conditions. The engine is of the four-cylinder type of 54 brake horse-power, and drives through a Hele-Shaw multi-disc friction clutch. Between the clutch and the main gear-box there is a subsidiary gear-box for reversing purposes, so that the four speeds of the main box are available in either direction. The controls are duplicated at both ends of the vehicle, as are also the radiators, so that the coach can be run in either direction with equal facility. The change-speed levers, we note, are of the "gate" type and are so interconnected that it is impossible for anyone to interfere with their action from the end opposite to the driver. The same is the case with the pedals for the clutch, the sanding gear, hand brake, &c.

The springing arrangement is peculiar, as the springs are mounted on special carriages outside the wheels, with the result that they are set at 6ft. 6in. centres, instead of the normal 3ft. 6in.

In addition to the hand brake, which acts on the transmission system, Westinghouse air-pressure brakes are applied to all the four driving wheels, the compressed air for this purpose being supplied from a small compressor driven from the front end of the gear-box. This compressor also supplies the air reservoir for the whistle. The brake can be applied from either end, but the driver's control lever is detachable, and is taken off by the driver when he moves from one end of the car to the other. In addition, a conductor's emergency valve is fitted in the car at each end. Cocks are provided in the water circulating pipes, so that, if desired, the water may be passed through heating coils in the body of the car, while louvred shutters are fitted on each radiator, so that the temperature of this water may be controlled by the driver, each radiator being fitted with a temperature indicator on the cap. A dynamo for electric lighting and a self-starter are provided.

This particular vehicle is, the makers inform us, capable of a speed of about 30 to 35 miles per hour, and under ordinary conditions can haul about 40 tons, although in an emergency about twice this amount could be moved.



FOUR-WHEEL-DRIVE PETROL RAIL COACH CHASSIS

NEW TYPE OF CHAIN GRATE STOKER.

WE have received from Ed. Bennis and Co., Limited, of 28, Victoria-street, Westminster, some particulars of tests carried out recently on a Babcock and Wilcox boiler fitted with a new type of Bennis chain grate stoker. The principal feature of the stoker is the use of a specially narrow link, which increases the air space, and is said to enable the combustion of about 20 per cent. more fuel per square foot of grate than is possible with the ordinary stoker. Incidentally, the life of the links is increased, as they are cooled efficiently. The tests in question were made at the Cwmaman Colliery, near Aberdare, where there were four hand-fired boilers and one fitted with the stoker. The coal used was the ordinary unwashed colliery small, which had a volatile content of about 9 per cent., and from 16.5 to 22.5 per cent. of ash. The water evaporated was measured by a 4in. Siemens meter. Several tests were made, on different days, and the average of the results was as follows:—Evaporation, from and at 212 deg. Fah., of the hand-fired boilers, 8958 lb. per hour; for the boiler with the Bennis stoker, 14,858.5 lb., which shows that the capacity of the boiler was increased by about 65 per cent. by the addition of the stoker. At the same time a good efficiency was maintained, as it was calculated to be 75.85 per cent., as against a guarantee of 70 per cent., and this was secured with coal inferior to that specified, as it ranged from 11,021 B.Th.U. to 11,547 B.Th.U. per pound, as compared with 12,500 B.Th.U. in the specification. The average water evaporated, from and at 212 deg. Fah., per pound of fuel was 8.825 lb. per hour.

LAUNCHES AND TRIAL TRIPS.

REDLINE No. 1, single-screw steel steamer; built by Harland and Wolff, Limited, to the order of Andrew Weir and Co.; dimensions, 120ft. by 23ft. by 10ft. 6in. Engines, triple-expansion surface condensing; constructed by the builders; delivered November 5th.

CABIMAS, oil tank steamer; built by Palmers Shipbuilding and Iron Company, Limited; to the order of The Gulf Refining Company; dimensions, 290ft. by 47ft. by 16ft. 6in.; to carry 2700 tons. Engines, one set of triple-expansion; pressure, 180 lb.; constructed by MacColl and Pollock; launch, November 11th.

CITY OF MANDALAY, steel single-screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Ellerman Lines, Limited; dimensions, 443ft. by 57ft. 6in. by 34ft. 4in.; to carry 11,250 tons. Engines, inverted direct-acting triple-expansion, pressure 225 lb.; constructed by the Wallsend Slipway and Engineering Company, Limited; launch, November 12th.

TIGON, drag suction hopper dredger; built by W. Simons and Co., Limited; to the order of the Anglo-Persian Oil Company. Engines, two sets of triple-expansion, surface-condensing; constructed by the builders; launch, November 12th.

ANTINOUS, steamer; built by Workman, Clark and Co., Limited, to the order of the New Egypt and Levant Shipping Company, Limited; dimensions, 415ft. long; 4600 gross tonnage. Engines, triple-expansion; constructed by the builders launch, November 18th.

Radio Communications.*

Many theories have been evolved to explain why it is that electric waves can reach distant places and as to how they can bend right round the globe so as to be received with ease even at the Antipodes instead of shooting off into space.

They have not, however, satisfactorily explained to my mind why waves of a certain length will cover great distances by daylight, whilst others will only cover similar ranges at night time.

On July 2nd of this year I had the honour to read a paper before this Society on "Results Obtained Over Long Distances by Short Wave Directional Wireless Telegraphy," more generally referred to as "The Beam System."

In that paper I described the results obtained during many years of systematic research carried out by myself and by engineers of the Marconi Company, with the object of evolving a practical directive system of radio communication.

Most people may now agree with me that wireless waves are far too valuable to be always broadcasted in all directions, especially when it is desired to communicate only with one particular place, and I do not understand why, for example, messages which may be intended for Canada or South Africa should be scattered simultaneously pretty well all over the rest of the world.

I can well understand the utility of the non-directional stations for many naval and marine purposes, and, of course, for broadcasting; but for ordinary efficient communication between fixed places, or between one country and another, I think the right and logical thing to do, if possible, both from the point of view of secrecy and of economy, is to concentrate all the radiated energy into a beam directed towards the country or place with which it is desired to communicate.

The number of available wave lengths is, after all, very

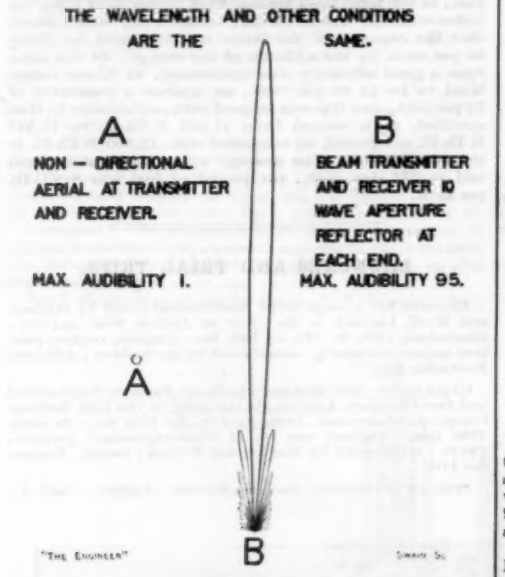

POLAR DIAGRAMS ILLUSTRATING RELATIVE AUDIBILITY AT EQUAL RANGE AND WITH EQUAL TRANSMITTING POWER. ASSUMING THE WAVELENGTH AND OTHER CONDITIONS ARE THE SAME.
A
NON – DIRECTIONAL AERIAL AT TRANSMITTER AND RECEIVER.
MAX. AUDIBILITY 1.
B
BEAM TRANSMITTER AND RECEIVER 10 WAVE APERTURE REFLECTOR AT EACH END.
MAX. AUDIBILITY 95.
A
B
"THE ENGINEER"
SMAIN SC.

FIG. 1

far from being unlimited, and if a wave length which is being utilised for communicating between England and India should necessarily be allowed to spread to Africa and America, it would most probably interfere with the free use of that wave in these other countries and also debar our use of that same wave for communicating simultaneously with them.

Fig. 1 shows polar diagrams illustrating relative audibility at equal range and with equal transmitting power, assuming the wave length and other conditions are the same.

A. Non-directional aerial at transmitter and receiver.

B. Beam transmitter and receiver 10 wave aperture reflector at each end.

During the tests carried out on the steam yacht Elettra in the spring and summer of 1923, I was able to discover that the short wave I was then using could, in fact, not only cover great distances by day, and much greater distances by night, but that they were also quite reliable, and that, moreover, large parts of continents and ranges of mountains did not materially reduce their working distance.

A series of tests was for the first time carried out with short waves over what might be termed world-wide distances during the winter, spring and summer of this year, between Poldhu in Cornwall and receiving stations situated on ships at sea, and also at such places as Montreal, New York, Rio de Janeiro, Buenos Ayres and Sydney (New South Wales).

All these tests proved to be successful, including the first telephonic communication with Australia ever realised, although the amount of power utilised at the sending station never exceeded 20 kilowatts.

Very strong signals were obtained at all these places during the hours when darkness extended over the whole distance separating each of them from Poldhu, and weaker signals for a few hours when the sun was above the horizon at either end, the intensity of the signals varying inversely in proportion to the mean altitude of the sun when above the horizon.

Although the signals were received with great strength at New York, Rio and Buenos Ayres during the time when darkness spread over the whole or at least the major part of the great circle track separating these places from Poldhu, no signals at all were ever received, during these tests, when the same track or part of space was all, or substantially all, illuminated by the light of the sun.

While this limitation of the period of working to practically the hours of darkness constituted an undoubted disadvantage, still the economical advantages, together with the reliability and possibility of working this system, at far greater speeds than would have been feasible with the well known high-powered long wave installations, went far to convince me that the short wave beam system would be capable of transmitting a far greater number of words per 24 hours between England and far distant countries, such as Australia, than would be possible by the comparatively powerful, cumbersome and expensive stations actually in use, or which were planned to be used, for Imperial commercial communications.

It is a satisfaction to me to be able to state that the stations intended for this purpose in England, which we are now erecting under a contract with the Post Office, and others to be installed in the principal Dominions and far distant countries will all be on the Beam system.

Commencing in August of this year, a further series of investigations was carried out between Poldhu and the yacht Elettra, the object being to endeavour, if possible, to find means of overcoming the limitation of working hours brought about by daylight, and also to test whether the effect of the reflectors would give the expected increase of signal strength over long distances.

The yacht proceeded to Spain, then to Madeira, and afterwards to Italy. From Naples we sailed for Beyruth in Syria, touching at Messina and Crete, returning to Naples *vid* Athens.

At Madeira it was ascertained that a reflector at the transmitting station increased the strength of the received signals in accordance with our calculations, but that, notwithstanding this increase of strength, when using a 92 m. wave the daylight range was only very slightly augmented.

At Madeira, and at other places, in the Atlantic and Mediterranean, comparative tests were carefully carried out with waves of 92, 60, 47 and 32 m.

These tests enabled us to discover that the daylight range of practical communication over long distances increased very rapidly as the wave length was reduced, the 32 m. wave being regularly received all day at Beyruth, whilst the 92 m. wave failed to reveal itself for many hours each day even at Madeira, notwithstanding the fact that the distance between Poldhu and Madeira is 1100 miles, entirely over sea, whilst that between Poldhu and Beyruth is 2100 miles practically all over mountainous land.

Comparative tests on different waves lengths were carried out for a period of over two months, in a variety of places, and all observations went to confirm the fact that for waves between 100 m. and 32 m. the daylight absorption decreased very rapidly with the shortening of wave length.

These results were so interesting and satisfactory that I immediately decided to try further tests over much greater distances.

In October of this year transmission experiments were carried out on a 32 m. wave from Poldhu to specially installed receivers at Montreal, New York, Rio, Buenos Ayres and Sydney (Australia).

Although the available power utilised at Poldhu was only 12 kilowatts, it was at once found possible to transmit signals and messages to New York, Rio and Buenos Ayres when the whole of the great circle track separating these places from Poldhu was exposed to daylight.

During a complete day transmission at fixed intervals carried out last October with Sydney, New South Wales, that station received the Poldhu signals for 23½ hours out of the 24, and a 48-hour test, which was only completed a few days ago, fully confirmed the result.

The tests from England to places situated south of the Equator, such as Sydney, Buenos Ayres, Rio de Janeiro and Cape Town, are particularly interesting for the reason that the waves have always in these cases to traverse what may be called a summer zone, and are therefore subjected to an averaging effect of conditions, which can never possibly exist when the transmissions take place only between stations situated in the northern or southern hemispheres.

During November some successful receiving tests were carried out in England from a low power transmitting station in Australia utilising waves of 87 m.

During the present month of December trials have been continued with Canada, the United States, Brazil, the Argentine and Australia, and also, for the first time, with Bombay and Karachi in India and Cape Town in South Africa. The power utilised at the Poldhu station during all these tests was 15 kilowatts.

Fig. 2 is a map of the world showing rough great circle tracks between Poldhu and various places where systematic receiving tests were carried out.

The results have fully confirmed my expectations in regard to the behaviour of the various wave lengths over such great distances, and I have no doubt that the information gained will render possible the installation of comparatively low power stations capable of establishing and maintaining commercial services by day and by night between England and the most distant parts of the globe.

The low cost of this system, both in capital and running expenses, compared with that of the existing type of stations, must prove to be very great, and should bring about the possibility of a reduction in telegraph rates for all long-distance communications, besides making direct communication with some of the smaller outposts of the Empire commercially remunerative.

Already the size and power of some of the most modern long-wave stations was becoming a serious question from a financial point of view.

I am now firmly convinced that the Beam stations employing only a small fraction of this power and much lower and fewer masts, will be able to communicate at practically any time with any part of the Empire, and I cannot refrain from expressing my strong personal opinion that these powerful long-wave stations will soon be found to be uneconomical and comparatively inefficient in so far as long-distance commercial communications are concerned.

What remains now to be done is to complete the systematic study of these waves especially in regard to their transit or propagation through space. They open up what I believe will prove to be a most fertile field for the investigator and an entirely new horizon to our view.

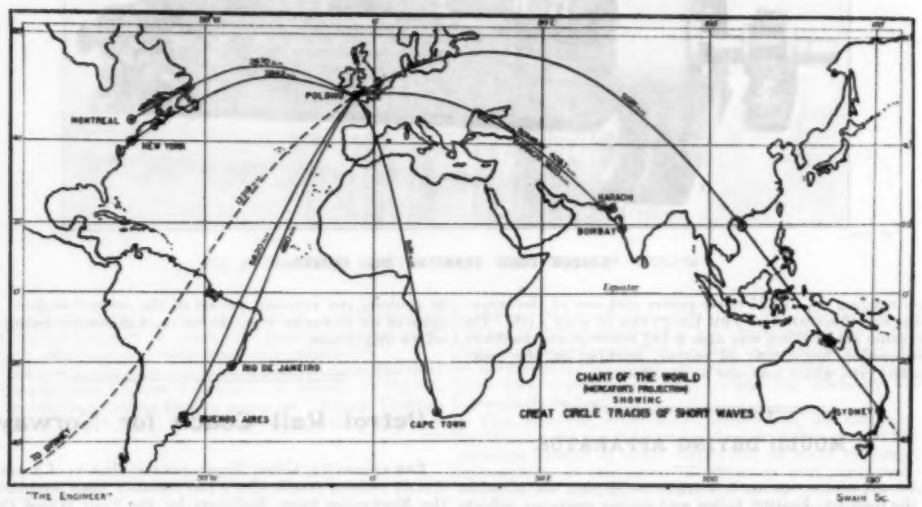


FIG. 2—MAP SHOWING SHORT WAVE TRACKS

I think that it will be admitted that these results indicate quite definitely that the well-known Austen formula is inapplicable to these waves. Another formula will have to be devised, based on the results of further investigations.

Reflectors of practical and economical dimensions are only efficiently applicable when short waves are used, and although very long distances have been covered by these waves without the use of directional devices, I am convinced that these will be found to be essential for ensuring the carrying out of commercial high-speed services. The disadvantageous effect called "fading" is sometimes a source of serious trouble when receiving signals transmitted by means of these waves, although much less serious than when waves of several hundred metres in length are employed.

According to our experience the use of reflectors diminishes fading, and also tends to overcome its effects by enormously increasing the strength, and therefore the margin of readability, of the received signals.

Increasingly large and expensive reflectors could, of course, be used with longer waves than 100 m., but the results of all recent tests seem to indicate that the shorter waves present the greatest advantages, one of the most important being that their reception is very much less liable to interference by the effects of atmospheric electrical disturbances, or "X's."

If these waves are destined to carry a considerable part of the most important long-distance telegraphic traffic of the world, it may well be necessary in the near future, by international legislation, to regulate their use and safeguard them from preventable interference.

All the civilised world is now interested in what is called broadcasting, and in England alone over one million receiving sets have been licensed by the Postmaster-General.

The results obtained by amateurs have often been of great value in helping us to come to somewhat better understanding of the phenomena involved, and I might remind you that amateurs have recently been able to carry out two-way communication with New Zealand for brief periods.

Toronto's street railway system will, on the completion of the rehabilitation of the old lines, have a capitalisation of approximately 40,000,000 dollars.

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* Abstract of inaugural address delivered before the Royal Society of Arts by Senatore Marconi.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Seasonal Slackness.

THE approach of Christmas and stocktaking has resulted in the usual falling off of business in the Midland iron and steel trade, and on 'Change in Birmingham to-day there was but a poor attendance. There was manifest a general disposition to postpone buying until the New Year. Most consumers have covered their requirements, and as prices in some departments showed a slightly weaker tendency, this further encouraged a waiting policy. There is, however, a confident tone about the market, and the New Year's prospects are considered to be fairly satisfactory.

Railway Programme Welcomed.

The elaborate fourteen million programme upon which the London, Midland and Scottish Railway has decided to embark, following upon the announcement just about a fortnight ago by the North-Eastern Railway Company of its plans for spending six millions makes pleasant reading, and to say that industrialists in the Midlands are pleased is to put it very mildly. It is realised that quite a nice proportion of the work may reasonably be expected to come to engineering and rolling stock firms hereabouts, and the fact that arrangements have been made for the issue of orders and contracts in such a way that manufacturers need not in consequence of this work be obliged to refuse orders from abroad is much appreciated. The work contracted for, or contemplated, will consume a very large amount of steel and a certain amount of best iron, and South Staffordshire ironmasters are well prepared to meet the demand. Spread over a considerable period it will put no strain on productive resources. With the advent of the New Year, and, assuming that the better trade which everybody is anticipating materialises, the activities of the railway companies in carrying out their programmes of reconstruction and re-equipment ought to be an appreciable factor in helping to place the iron and steel trade of this district on a better footing.

Steel.

In the steel trade there is an absence of heavy orders for such products as rails, joists, &c., but a fair quantity of constructional work has been given out giving moderate employment to mills. Some works have good orders for light plates. Steel prices are somewhat irregular. Competition in the home market continues to be very keen. Especially is this the case for the business offering in small steel bars, and something less than £9 5s. has been accepted in special cases. Common tube strip commands £9 10s., and bedstead angles £9 10s. to £9 15s. Mild steel billets are a shade cheaper. Price cutting has become more active of late, and Welsh makers are glad to take orders from the Midlands at £7 10s. It is stated that 5s. less would not be refused in some quarters for desirable business. Continental makers are not such keen competitors as they were, many of them having bookings until February, but it is well known that this is due largely to German buying, regarded by most authorities as a temporary phase. No great reliance is placed upon the somewhat firmer conditions on the Continent. Belgian steel billets are obtainable at £6 10s. delivered, offering an advantage of 15s. to £1 per ton. Finished steel bars are quoted £6 2s. 6d. f.o.b. Antwerp, giving a decided advantage as against native material. The production figures for November show that the output of steel ingots and castings amounted to 672,800 tons, compared with 678,500 tons in October and 645,000 tons in September.

Scrap.

The steel scrap market continues sluggish, and holders of stocks find much difficulty in securing purchasers even at £3 10s. per ton delivered. Most consumers have definitely postponed buying until the New Year. Holders of wrought iron scrap show their confidence in the forward position by refusing the £4 15s. lately ruling, but so long as the outlook remains undefined buyers will not bid higher.

Raw Iron.

There has been a rather noticeable falling off in demand for pig iron this week, and on 'Change in Birmingham to-day—Thursday—there was little more inquiry for foundry sorts than there has been of late for forge grades. Most consumers of raw iron have covered their requirements between now and the Christmas holidays, and at some of the Midland works stocktaking is already beginning. Production will be irregular for some weeks to come, and little raw material will be needed. Deliveries are being called for very slowly against the purchases made in October and November, more slowly than had been reckoned upon. Northamptonshire and Derbyshire smelters found that if they were to do business they must accept lower prices. This they are very reluctant to do, but on 'Change to-day, last week's best prices were seldom realised, sellers having to be content with the slightly lower values. There is little North Staffordshire iron to be bought, and prices are firmly maintained at £3 17s. 6d. for forge and £4 7s. 6d. for foundry. Northamptonshire forge sells at £3 11s., and foundry at £3 16s. to £3 17s., Derbyshire forge is offered at £3 16s. 6d. to £3 17s. 6d., and foundry at £4 2s. 6d. Only those blast-furnaces which were under pressure to sell were disposed to accept the low prices offered, the rest being content to hold on believing that the turn of the year will bring a reinvigoration of demand. There is a good deal of confidence in the trade which the New Year has in store. The production of pig iron in November, it is interesting to note, amounted to 583,500 tons, compared with 586,400 tons in October. The furnaces in blast at the end of the month numbered 173, an increase of two since the beginning of the month, four furnaces having been blown in and two damped down or blown out. The production includes 197,500 tons of hematite, 178,800 tons of basic, 150,300 tons of foundry, and 31,700 tons of forge pig iron.

Staffordshire Iron.

The Staffordshire iron trade finds business less easy to obtain, and practically all the works are wanting orders except makers of best bars, who are very well situated, and easily maintain their £15 figure. Some of these works have orders for months forward. In the Crown bar and nut and bolt bar department there is not much activity, though the hope is entertained that the substantial orders placed with the makers of railway rolling stock may result in a large call being made upon the mills. Price unsteadiness is becoming more apparent in these branches, and increasing difficulty is experienced in obtaining the prices lately paid for Crown bars and common bars. The official quotations are, however, unaltered. Crown quality bars are quoted at £12 15s., and bars of nut and bolt quality at £11 15s. per ton. The relatively high price of Staffordshire nut and bolt iron provides a good opening for continental competition, and Belgian works are offering supplies of No. 3 iron suitable for use in the nut and bolt trade at £7 17s. 6d. to £8 per ton delivered in the district. It is said that an increasing proportion of nuts and bolts are made of foreign material. Wrought iron gas tube strip prices continue abnormally high—£13 5s. per ton—with the result that steel is preferred increasingly for gas and steam tubes and similar requirements. A fair quantity of iron tube strip is being bought, the tube mills being fairly busy, but the demand for steel strip at £9 10s. per ton is much larger. A large proportion of the latter material is rolled from foreign slabs.

Galvanised Sheets.

Galvanised sheet prices are slightly easier this week, corrugated sheets of 24-gauge ranging from £17 7s. 6d. to £17 10s. Some mills are eager for new business, but they refuse to accept orders at £17 5s., the price offered by some consumers. The export demand, like that at home, is very quiet. Thin gauge material is, however, a better market.

Fuel Economy.

The imperative need for fuel economy and conservation was urged at a meeting of the Birmingham University Metallurgical Society on the 9th inst. by Mr. A. J. G. Smout, who delivered an address on "Fuel Economy with a Special Reference to the Metal Industry." He spoke of how waste fuels could be utilised in the metal industry; how furnace efficiency could be increased and how a complete reorganisation of a great fuel consuming industry, such as iron and steel manufacture, could revolutionise fuel consumption. Fuel economy could be effected in works by using lower grades of fuel, but to do that profitably there must be the right type of fuel, adequate furnace control, and a furnace specifically designed for the purpose on hand.

Workless.

The weekly statistics of unemployment in the Midlands show a further slight improvement, the numbers on the unemployment Exchange being 139,362, as compared with 139,539 the previous week. Of the total, 99,144 are men, 1471 boys, 36,173 women, and 2574 girls. The returns for the principal towns are:—Birmingham area, 30,317; Bilston, 3177; Coventry, 1889; Cradley Heath, 4303; Derby, 2079; Dudley, 4254; Hanley, 3110; Leamington and Warwick, 661; Leicester, 3957; Longton, 3238; Northampton, 1590; Nottingham, 8927; Oldbury, 1702; Peterborough, 536; Smethwick, 4444; Stourbridge, and Brierley Hill, 4136; Tipton, 2215; Walsall, 5350; West Bromwich, 3283; Wolverhampton, 5285; Worcester, 1975; and Redditch, 1228.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Outlook.

As the year approaches its end there is a decided slackening in the volume of business passing on the Manchester market, but apparently no feeling of weakness. Sellers are for the most part content to wait patiently for what the New Year will bring, and in many cases manufacturers are rather reluctant to commit themselves to forward business, because it is very generally believed that more favourable prices will be available when the stocktaking and holiday periods are over. That there will be a better state of trade next year than there has been this year may perhaps be admitted even by those who are pessimistically inclined; but, of course, it does not follow that this necessarily means a higher range of prices, and indeed many people think that permanent better trade can come only when the level of prices is very much lower than at present.

Metals.

There seems to be a slow strengthening process going on in the markets for the non-ferrous metals. It is intermittent in its action and one cannot tell from day to day when a check may come, but it seems probable that the general movement may be depended upon. There are, of course, exceptions, as in the case of lead, where the upward movement in prices has already taken the metal to what seems a giddy height; although it is true that some people in the market predict still higher prices. It is wise, however, to look askance at lead, for if it should move up a little further there will be an attack by powerful "bears." Copper is in a totally different category, and it is just now one of the safest metals to hold. There will, of course, be fluctuations, but the tendency now amongst speculators is to buy on every setback, and this, of course, causes an early recovery. The only real danger to copper is in the possibility of extravagant increase in production by the American copper companies. One has to admit that these producers, if they choose, can make more copper than the world is yet capable of absorbing, but it is not very likely that many of them will damage their own prospects by doing so, and it is true also that the world capacity for the absorption of copper is still growing. Of course, the main point in favour of copper is that it is a relatively cheap metal. It is exceedingly cheap in relation to lead, and is relatively cheap in relation to spelter and tin. In fact, it is now about the only cheap non-ferrous metal in existence. Tin has been as usual moving backwards and forwards without any definite tendency, but, on the whole, the market keeps fairly strong, and we have no indication of any probable return to the prices of the early autumn. Just at the moment it would appear that the statistics of tin at the end of the month will be somewhat against the market, as large shipments from the East are taking place. This may have an effect for a time, but the basic fact remains that the consumption of the world has been large enough to get rid of the old surplus. A sharp revival in the American tin-plate trade would put a different complexion on the market at once. Lead and spelter are both very strong markets, but, of course, the latter is in a safer position than the former. German consumption of spelter seems to be on the increase, but consumption here is not too good.

Pig Iron.

The position in the market for foundry iron does not alter much here. Sellers are steady and firm at 90s. per ton delivered in the Manchester district, and there is very little other than Derbyshire iron being offered here now. Northamptonshire might be bought at a little less, as the furnace price for that iron is some 5s. lower than the furnace price for Derbyshire; but the carriage almost covers the difference. Moreover, not very many Manchester ironfounders care to use Northamptonshire foundry iron unless they can get it much more cheaply than Derbyshire. Cleveland iron still costs about 94s. per ton when delivered in Manchester. Scotch and hematite irons are both steady at the late prices. For forge pig iron there is only a small demand here, and indeed it must be small all over the country, for the total quantity of forge iron made last month in Great Britain was only about 30,000 tons out of a grand total of 583,000, or a little over 5 per cent. These figures indicate what is happening to the malleable iron trade of Great Britain. There seems to be a very general expectation here that foundry iron prices will be higher after the turn of the year; there are, however, still sellers here who will take orders up to the end of March at to-day's price. If, however, there should be a revival of demand sufficient to send up the price, one cannot help thinking that more of the Midland furnaces will be started.

Finished Material.

There is very little inquiry here for manufactured iron and the demand for finished steel is not very much better. Slight concessions in the price may be obtainable for prompt steel specifications, but the ordinary prices remain as they were, at £9 per ton for joists and angles, £9 15s. to £9 17s. 6d. for flat bars, £10 to £10 5s. for round bars, and £9 15s. for common steel plates. Continental prices have been a little easier, but there is not much change.

Scrap.

In the scrap markets a better feeling prevails, and there is an expectation of considerable improvement in the near future. Dealers here are stiffening, although there are still some weak holders who quote low prices. As a rule dealers now want 87s. 6d. to 90s. for the finer lots of broken machinery metal, and 82s. 6d. to 85s. for the ordinary lots; but one hears of sales at 80s. The hope seems to be that Lancashire ironfounders will be much busier in the New Year and will be requiring more scrap to mix with pig iron. So far there are no buyers of steel scrap at good prices, and probably 75s. delivered in Sheffield is as much as could be obtained for an immediate sale; but steel scrap is reported as not too plentiful in the Sheffield district, and dealers expect to get 80s. for it next year. Meantime they offer only 65s. at the most for lots at a Lancashire station. Heavy wrought scrap is quiet and neglected, and about 80s. per ton is all that the ironworks in Lancashire are offering for it.

Manchester Association of Engineers.

There was an attendance of about 450 members and ladies at the conversazione of the Manchester Association of Engineers at the City Art Gallery, given by the president of the Association, Mr. Herbert Bates, M.I. Mech. E., on Friday, the 12th inst. Although the municipal art gallery is a somewhat unpretentious building for such an important city as Manchester, it seems to house one of the finest collections of works of art in the country, including many paintings contributed by the executors of the late Mr. James Gresham of injector fame. In addition to having an opportunity of inspecting the works of art under pleasant conditions, the company was also entertained by an excellent concert of vocal and instrumental music, provided by the president, and the evening was generally voted a very happy one.

College of Technology.

The retirement of Mr. H. G. Jordan, M. Sc. Tech., M.I. Mech. E., lecturer in mechanical engineering in the Faculty of Technology at the Manchester College of Technology, is announced. Mr. Jordan has been a member of the tutorial staff of the college for forty-two years, and during that time many thousands of engineering students have sat under him. The good wishes of all his old pupils will go with him in his retirement. To commemorate the valuable services which he has rendered to technical education, Mr. Jordan has been elected a life member of the Manchester Association of Engineers.

Whitworth Scholarships.

The system upon which these scholarships are awarded has recently been the subject of criticism in the Manchester district on account of the remarkable number

of successful students from the naval dockyards of Portsmouth, Chatham and Devonport. Mr. Bates, president of the Manchester Association of Engineers, referred to the subject in his presidential address recently, and suggested that a special effort should be made to interest engineering apprentices in the valuable means of continuing their studies which these scholarships afford. Several prominent local engineers, whose names will occur to your readers, won Whitworth scholarships in the past, but in recent years there have been no Lancashire successes, and engineers are asking why that is so. I have made some inquiries and have arrived at the conclusion that the reasons why so few students are now endeavouring to win these scholarships are as follows :—Large numbers of youths serving their apprenticeship have not the opportunity of conforming with the conditions laid down as regards age limit. These conditions state, *inter alia*, that the candidate must not have completed the twenty-first year of his age on May 1st of the year in which he competes. Now it is extremely difficult for the average youth, who is partly earning his living, to put in during the five years, say, since he left school and before he reaches the age of twenty-one, the necessary time on the practical side in the shops, namely, thirty calendar months, and, in addition, to obtaining the necessary technical tuition which is in nearly all cases gained at evening classes. Even when a student is permitted by his employers to attend the apprentices' day course at the College of Technology, he has much difficulty in completing that course before he reaches the prescribed age limit. There is no doubt that the staff engaged at the Manchester College of Technology is quite capable of teaching the prescribed subjects, and from my own personal observations, I am quite sure that the Lancashire youths provide the right material to win these scholarships, given equal opportunities. Another possible reason why students from this district are not coming forward for the scholarships is that they do not know of them. Some ten or more years ago a "Whitworth" was the only title that the industrial student could aspire to, whereas now the Associateship of the College of Technology is offered to students who pass successfully the five years' evening course of the advanced apprenticeship evening course. They therefore aspire to the associateship, and possibly the teaching staff is directing its attention to them as being something more "immediate" than a Whitworth, with the result that the latter has been neglected. It would seem therefore that to give the average engineering apprentice a better opportunity to gain these coveted honours the age limit should be extended to, say, twenty-three years instead of twenty-one, and I venture to submit this suggestion to the Board of Education for its approval. It may, of course, be argued that the conditions are the same for all competitors, but the remarkable number of successes which have been gained by youths engaged in the Government dockyards would seem to suggest that at them some method of training is in vogue, whereby practical training and theoretical tuition are co-ordinated under conditions which do not appertain to ordinary industrial engineering.

BARROW-IN-FURNESS.

Hematite.

The hematite pig iron trade is improving, slowly but surely. A furnace has gone in blast at Millom and the output is being cleared. Other makers are experiencing a better demand, and what with the requirements by the steel departments at Barrow and Workington, the whole of the district's output is finding customers. What is more, many of the customers who a short time ago were satisfied to order for just their immediate requirements, are now placing orders for forward delivery. Merchants are also more inclined to place orders for forward delivery. The business being done in special qualities is not very large at the moment, but this trade is bound to improve in the early future, as engineers' requirements are increasing. The overseas trade is not big at present, but there are possibilities in that direction.

Iron Ore.

The business in native ores is increasing in view of the larger number of furnaces in blast ; but there is not much ore going out of the district yet, though there is a chance of that trade improving. There is rather a better tone in the foreign ore trade, and there is every possibility of improved imports in due course. Stocks are held in the district to a certain extent.

Steel.

There is no improvement to report in the steel trade. Both the Barrow and Workington rail mills are at work, but the orders held are not sufficient to keep them going for long. Perhaps Barrow is the better situated at the moment. The small section mills and the hoop mills at Barrow are fairly well off for orders, but not overstocked.

Shipbuilding and Engineering.

The return of Vickers Limited naval construction works of ships launched and engines completed shows a great improvement as compared with some of the preceding years. Ten vessels, varying in size from a London County Council sludge boat to an Orient liner, were launched. The total gross tonnage was 42,670 and the total horse-power 36,100. The latter figure includes Diesel engines for two cargo boats for the Mitsubishi Shoji Kaisha.

SHEFFIELD.

(From our own Correspondent.)

Reduced Production of Steel.

THE condition of the mild steel trade does not improve, and the outlook in this branch is not good. Something has to be allowed for the fact that, as usual at the year end, buying is being kept down to the minimum, so that the position may not be as bad as it appears. But the latest figures of production are not cheering. They relate to the month of October, and show a falling off. The figures for the Sheffield district were 35,200 tons of acid ingots, 28,900 tons of basic ingots, and 3300 tons of Bessemer, making, with castings, a total of 72,900 tons. As compared with September, this shows an increase of 33,000 tons, but in September output was seriously affected by a strike which shut down three of the largest works in the district. Contrasting the latest figures with those of October, 1923, they disclose a falling off of 15,000 tons. The output in Lincolnshire was 38,000 tons, all basic, as compared with 39,700 tons in September and 43,400 tons in October, 1923.

Railway Material.

The prospects for the heavy side of the manufactured steel trade which produces railway axles, tires, and springs are much improved by the announcement of large railway programmes. In addition to the £6,000,000 scheme of the L. and N.E.R. Company, which was referred to last week, we now have the big programme of the London Midland and Scottish, which is to involve an expenditure of nearly £14,000,000. The steel departments mentioned should therefore be able to look forward to a regular supply of work for the next twelve months, though whether it will be sufficient to keep them all fully employed is another matter. Their capacity is so great that many large contracts are required to keep them completely busy. The orders for wagons will be on a large scale. A further list of such orders, in connection with the L. and N.E. programme, has been published since I last wrote, and shows that the local firms to benefit include Hurst, Nelson and Co., Chesterfield ; Cravens Railway and Wagon Company, Sheffield ; Charles Roberts and Co., Wakefield ; and S. J. Claye, Limited, Long Eaton ; besides those Birmingham wagon works which are associated with Sheffield firms. The allocation of orders under the L.M. and S. scheme has not yet been announced, but as no fewer than 30,000 goods wagons are to be built, Sheffield and district firms should be able to look forward to considerable demands on their resources.

At Lincoln and Doncaster.

Clayton Wagons, Limited, Lincoln, which is among the firms receiving orders under the new L. and N.E. programme, has just made its first delivery to that company of cars forming part of the large contract which was placed with it some little time ago, when orders for twenty-nine trains of ten cars each were divided amongst the principal manufacturers of railway rolling stock. This is understood to be the first delivery made to the L. and N.E. Company in connection with these contracts. Doncaster will enjoy a good deal of activity under the new programme. The L. and N.E. Company has its own locomotive building works in that town, and it is expected that full-time employment will be provided there for a good many months. Hall, Lewis and Co., one of the firms which have received wagon contracts, has a branch at Doncaster. Hitherto this has been utilised for repair work, but now it is intended to install new machinery in order that complete building may be carried out.

The Lighter Trades.

The condition of the old staple trades of Sheffield has shown an improvement during the year, and the prospects are considered brighter. The general position cannot be described as good, but there are a number of instances of activity and progress, and cases of full-time working can be found. There are indications that increased supplies of Sheffield material will be required by engineers, railway companies, automobile builders, and shipbuilders, as well as those engaged in many smaller trades. A considerable improvement is anticipated during the first quarter of the New Year. The wire rope department continues brisk, but the wire rod mills are not doing so well, and are having to contend against increased foreign competition.

Cutlery and Plate.

The special orders received for cutlery and plate in connection with the Christmas sales have now been practically completed, but work is still active in several important departments. The cutlery trade is busy on the production of stainless steel table knives, while on the electro-plate side the production of spoons and forks and of cheap cased goods is maintained at a high level. There is some improvement in the overseas demand for best quality pen and pocket cutlery. The departments making the best cutlery and plate, although not busy, have been employed quite as well as they were last season, and there has been a considerable call for expensive cabinets and canteens.

Important Coke Oven Contract.

An especially interesting contract for the erection of a coal washing and by-product plant has been placed with Koppers Coke Oven Company, Limited, Sheffield, by the Blackwell Colliery Company, Limited, of Alfreton, Derbyshire. The coal washery will be designed on the Hunter-Baum principle and will have a capacity of 75 tons per hour, with storage and drainage bunkers of 2000 tons capacity. The particularly interesting feature of the contract is that the by-product coke oven installation will consist of a battery of forty regenerative ovens designed on the contractors' latest taper principle, and will be the first large installation of taper ovens to be erected in this country. A small trial battery of these ovens erected by the Koppers Company at Tinsley Park Colliery, Sheffield, has been giving very successful results during the last twelve months, and a similar trial battery is now under construction at the Dinnington Main Colliery. Ovens of this type have been largely adopted on the Continent, where at present there are over 1700 in operation and under construction. The Blackwell plant will be complete with coal and coke-handling arrangements, and residual recovery plant for the production of tar and crude benzol and for the manufacture of sulphate of ammonia. The coke-handling arrangement is designed in accordance with the contractors' American practice, and comprises a coke car driven by an electric locomotive, a central quenching station, and a mechanical loading and screening plant. The total cost of the complete installation, including railway sidings, steam boilers, &c., will be upwards of £200,000.

An Important Electrical Contract.

Sheffield is interested in a large contract obtained by the Metropolitan-Vickers Electrical Company, Manchester, for that company is amalgamated with Vickers Limited and has a branch works in Sheffield. The order is the largest that has ever been placed in this country for high-tension switchgear and transformers. It consists of 132,000-volt switchgear and transformers for the new Witbank generating station and Brakpan distribution station of the Victoria Falls and Transvaal Power Company, Limited. The value of the order is approximately £250,000, and the operating line voltage of 132,000 volts is said to be the highest ever undertaken for power transformers by any British manufacturer.

The Spalding Sugar Beet Factory.

Spalding Urban Council is taking steps to facilitate the erection of the great sugar beet factory in the town. At a special meeting last week it unanimously adopted a scheme for the improvement of the approaches to the site in Marsh Rails, including a £25,000 swing bridge over the river Welland near the factory, and a £5000 road from the bridge to the main Spalding-Boston road. It was also decided that the Marsh Rails road to the factory should be widened to 40ft. and strengthened. With reference to the Council's undertaking to guarantee a water supply of 1,000,000 gallons a day, it was thought that new mains would have to be laid from Guthram, and a sub-committee was appointed to decide the minimum sum payable for water by the Beet Corporation for ten years.

Public Transport Progress.

Chesterfield Corporation is quickly following up its decision to replace the present tram system with electric trolley omnibuses. An experimental vehicle was in the town last week, and several members of the Council had a trial trip in it. The Rotherham tramway system has been extended by means of trackless cars to Maltby, and the first of the new cars passed through the village on Sunday. Further extensions are in progress. The L. and N.E.R. Company has submitted plans for the new light railway from Gainsborough to Frodingham to the Gainsborough Rural Council, which has adopted them.

NORTH OF ENGLAND.

(From our own Correspondent.)

Ironworks to be Restarted.

THE usual seasonal quietness is being experienced in trade circles in the North of England, but quite a cheerful tone prevails, and confidence in the expansion of trade early in the New Year is as pronounced as ever. This confidence in the iron trade is reflected in the decision of Gjers, Mills, and Co., Limited, Middlesbrough, to restart the Ayresome Ironworks about mid-January, when the firm contemplates putting two blast-furnaces into operation. The ironworks have been virtually inactive since September last. Other firms are also making preparations with a view to putting idle plant into activity as soon as circumstances permit.

Cleveland Iron Trade.

Although the Cleveland iron trade has assumed a somewhat quiet appearance in contrast to the position at the beginning of the month, a confident feeling prevails regarding the outlook. Requirements on home account promise to expand considerably, and indication is not lacking of some likely improvement in the export trade, though at the same time there is a feeling that the firmer stand recently made by some continental consumers may not continue. Moreover, the prospects of an active export trade in local iron with America seem to be receding owing to the lighting up of a number of furnaces in the United States. Cleveland pig iron prices are rather easier, but any weakness is probably only of a temporary character. No. 1 Cleveland foundry iron is firm at 86s. 6d., but No. 3 G.M.B. is sixpence per ton cheaper than a week ago at 81s. 6d., whilst No. 4 foundry has dropped to 80s. 6d., and No. 4 forge to 80s.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade shows little alteration. Makers are still hampered by heavy stocks, notwithstanding recent substantial withdrawals to meet current needs. There is every reason, however, to anticipate steady strengthening of the statistical situation, and producers are not disposed to make any price concessions. There are still inquiries in the market from America for hematite. Mixed numbers are quoted at 88s. per ton, and No. 1 at 88s. 6d.

Ironmaking Materials.

Extreme quietness continues to characterise the foreign ore trade. Consumers show little disposition to do business, and with freights easier and a good deal of tonnage offering, values are less firm than they have been, but sellers still base market rates on best Rubio at 22s. 6d. c.i.f. Tees. Blast-furnace coke keeps steady, good Durham brands realising 25s. per ton delivered at the works.

Manufactured Iron and Steel.

There are no new features of moment in the manufactured iron and steel trade. Business is quiet owing to this being the recognised stocktaking period. The works will be closing for the holidays, but there is a general feeling of confidence that the New Year will see greater activity. No doubt the spending of the millions

on the railways will result in a good influx of orders, but the steel trade in the North of England can never really be brisk until the shipbuilders are busy. Prices are unchanged.

The Coal Trade.

The Northern coal trade outlook has brightened up considerably during the past few days as the outcome of an increased demand from many quarters for supplies over the early months of next year. There is, however, little variation to note in the general run of the market for this month. The collieries all report well filled order books and tonnage in good supply, and consequently for shipment before the New Year there is no pressure of sellers, and recent prices are maintained. Inquiries for supplies during the first quarter of next year encourage the hope that greater activity will be experienced in the Northern coalfield than for some time past. The French State Railways are busy booking up their requirements for the first three months, and, in addition to contracts already placed, additional information is now to hand stating that further orders have been received, and these include contracts for 50,000 tons of Durham steam coals for shipment from January to March at 17s. 6d. per ton c.i.f. Havre, Dieppe, &c. The principal contractors for the coaling stations, including Channel and Mediterranean supplies, have been contracting with the Durham collieries for various quantities of coal for monthly shipments over the whole of next year. The total quantities booked are stated to exceed 400,000 tons. The prices, of course, depend on the descriptions, and are stated to range from 18s. 6d. to 20s., according to brand. The Bordeaux Gasworks have placed orders for the supply of 10,500 tons of Wear gas coals for January shipment at 22s. 3d. per ton c.i.f. The tone of the market is certainly much firmer than a week ago, and prices, whilst tending upwards, so far show only occasional appreciation, but the tendency of movement is against buyers. The coke trade generally is quiet, but the demand for patent oven coke is improving, and stocks are becoming scarce.

SCOTLAND.

(From our own Correspondent.)

Conditions Unchanged Generally.

PROCEEDINGS on 'Change during the past week were quiet and without indication of an early improvement in business generally. Nothing of any importance is likely to occur until after the holidays, buying being practically at an end for this year. The extensive railway schemes recently made public will doubtlessly provide a considerable amount of work in the Clyde Valley, as well as in other districts, and if trade expands in other directions as anticipated the coming year will be a distinct improvement on the one just drawing to a close.

Pig Iron.

The pig iron market has become quieter again. Local buying has fallen off, consumers being evidently well covered over the vacation. An encouraging feature, however, is the better inquiry on export account. Prices are practically unaltered and may remain so until stocks in makers' yards are further reduced.

Finished Steel and Iron.

So far as regards steel works producing plates and sections a considerable portion of the plants still remains idle, and there is a strong possibility that the holidays may be prolonged. Specifications have been exceedingly scarce. Home prices are unchanged. Sheet makers are practically all fully employed and are likely to continue so for some time, especially on export orders. Thin sheets have been the principal demand, but heavy sheets are improving. Ordinary black sheets are comparatively well off, but galvanised flat and corrugated varieties are especially busy. Prices of the latter are very firm. Bar iron makers have nothing new to report. Small lots are going to local engineers and wagon builders, but business generally is very unsatisfactory. The basis quotation for bar iron is unchanged at £12 per ton, but a keener price could be obtained for a good order. The re-rolled steel department of this industry is almost as poorly placed as the bar iron section. The business passing even with sheets at about £9 per ton home or export is disappointing, to say the least of it. A somewhat better note is struck in the improved demand for scrap material. Consumers are evidently more anxious to cover future requirements, and with supplies restricted prices are strengthening.

Coal.

A slightly firmer tone is apparent in certain descriptions of fuel, owing partly to covering of commitments to the end of the year and over the holidays. Lanarkshire splints have been so well booked up that the collieries have nothing available until after this month, and the only lots obtainable are through second-hands. The colliery quotation is firm at 24s. per ton for best quality and 20s. per ton for second quality, while second-hand lots are about 1s. 6d. per ton lower. Lothians steams have become somewhat scarce and the price for best brands is a shade firmer at 18s. per ton f.o.b. Leith. Fifeshire steams improve more slowly, but first-class qualities are now moving more freely at steady prices. Single nuts and pearls are the busy features amongst washed materials. Double nuts are moderate, but trebles are difficult to clear. Aggregate shipments amounted to 261,374 tons, against 275,449 tons in the preceding week and 308,141 tons in the corresponding week last year. The home market is quieter than usual in all departments. Industrial demands are far below normal, while the mild weather is responsible for a slackness in domestic fuel.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

ALTHOUGH it cannot be said that at the moment there is any real improvement in the coal trade outlook for next year, the fact that the Mining Association has suggested to the leaders of the Miners' Federation the establishment of a small committee representative of the two parties to consider the position of the industry and possible remedies for its present condition, is regarded as all to the good by those who are interested in the trade. The executive of the Miners' Federation could not very well do otherwise than accept the invitation, but it is understood that its representatives on the sub-committee in question will not have powers of negotiation, for the reason that the miners have not yet formulated their demands in respect of the new agreement. However, the move made in the direction of an amicable discussion of conditions, and the mere prospect that any new agreement that may be arrived at will be brought about in good time and with the minimum amount of threats of untoward developments, will serve to remove the feeling of nervousness and help business. The past week has seen further operations in steam coals for delivery over next year, and it is stated that foreign depôt owners have contracted for superior Monmouthshire qualities on the basis of 25s. 6d. f.o.b., while the report is current that about three-quarters of a million tons of best Black Vein large and Western Valleys large coals have been sold by some of the leading collieries for shipment to Italy over next year. The prices mentioned in this case is 25s. 6d. for best Black Vein large and 24s. 6d. for Western Valleys large. In relation to the output the above quantity is, of course, not very considerable, and it is known that many exporters have not so far summoned up courage to go in and purchase their possible requirements over 1925 at these prices. It is, of course, somewhat different with those buyers who have a definite outlet for coals, such as depôt owners, who must take steps to cover part, if not the whole, of their requirements.

Anthracite Trade Dispute.

Trouble has recently been threatening in the anthracite section of the coal industry consequent upon the demand on the part of the workmen that boys employed on the surface should be paid the same rates of wages as apply to those working underground. The question has been discussed by the Conciliation Board, and there now appears every prospect of the matter being adjusted. It was reported at a meeting of the South Wales Miners' Federation Executive on Monday that the negotiators have practically arrived at a decision for submission to the men. In view of this Mr. Enoch Morrell has been appointed to attend the next meeting of the Anthracite District to explain the position prior to the men being asked to accept the terms of settlement.

Anthracite Colliery Deals.

The announcement is made that the Raven and Garnant anthracite collieries near Ammanford, which belong to the Ashburnham group of collieries, controlled by Sir Beddoe Rees, have been disposed of to a new undertaking to be known as the Raven Anthracite Collieries, Limited, the chairman of which is Sir Arthur Lowes Dickinson. Although not officially disclosed, it is stated that the purchase price is in the neighbourhood of half a million pounds, and that it is the intention of the new owners so to develop the property so as to secure an output of 1000 tons per day of best quality anthracite. Another property which it is understood is changing hands is the Trimsaran Collieries at Trimsaran, which belong to Mr. Evan Jones, who acquired them some years ago. No definite statement is forthcoming as to the purchasers, but here again the purchase price is said to be about £500,000. The property embraces the Caeduan and Waunhir collieries at Trimsaran, about six miles from Llanelly, which employ about 700 workmen.

Tin-plate Trade.

Welsh tin-plate manufacturers at a meeting held at Swansea on Friday last unanimously decided to continue the scheme for the stabilisation of prices of tin-plates for another year, viz., until January 15th, 1926, and also to maintain the present price of 23s. 6d. basis f.o.b. There is no doubt that the decision will meet with pretty general satisfaction, as it is contended that the scheme since its introduction has had a valuable and beneficial influence on the trade. Middlemen have opposed the continuation of the scheme, but the fact that manufacturers are unanimously in favour of its continued operation is convincing evidence that the scheme is of inestimable value to the industry.

Boatmen's Tariff.

The Cardiff district Shipping Federation recently received from the boatmen at South Wales ports a demand for a revised and increased tariff of remuneration. The matter came up for consideration at a meeting of the Boatmen's Panel of the Central Joint Control Board for dock pilots, boatmen, &c., on Monday, when the application was refused. Mr. D. Radcliffe, speaking on behalf of the Shipping Federation, stated that it was impossible in the present depressed state of shipping to concede any increase to the workmen concerned.

Steel Work Order for Swansea.

It is announced that Sir William Arrol and Co., of Swansea, have secured an order for about 500 tons of structural steel work in the giant switchback which is being erected next year at the Paris Exhibition. The order was obtained in the face of keen continental competition, principally as the result of the firm's guarantee of quick delivery, which was largely made possible by its association with Baldwins, Limited, the great steel undertaking of this district.

Current Business.

Operations on the steam coal market have become rather quieter this week, partly for the reason that most exporters have now completed their arrangements for shipment before the holidays, while it is also the case that many of the leading coals are so fully stemmed that it is questionable whether further quantities can be secured. The tone of the market is on the whole very steady, except possibly in the case of some of the inferior descriptions, and it is fully expected that these conditions will be maintained throughout the remainder of this month, particularly as half a week's output will be lost during Christmas week. The anthracite market continues to be quietly firm, and most collieries are well stemmed for several weeks.

CALENDARS, DIARIES, &c.

KENRICK AND JEFFERSON, Limited, West Bromwich.—Calendar with daily tear-off sheets.

HULSE AND CO., Limited, Ordsal Works, Manchester.—Wall calendar with monthly tear-off sheets.

JOHN ROGERSON AND CO., Limited, Wolsingham, S.O., Co. Durham.—Wall calendar with monthly tear-off sheets.

BRUCE PEEBLES AND CO., Limited, Edinburgh.—Set of renewal cards for "Peebles" up-to-date metallic calendar.

LAW LAND COMPANY, Limited (Building Department), 30, Norfolk-street, Strand, W.C. 2.—Small pocket diary, containing general information.

BIRMINGHAM SMALL ARMS COMPANY, Limited, Birmingham.—Copy of Jessop's calendar with daily tear-off sheets. Wall calendar with monthly tear-off sheets.

HART ACCUMULATOR COMPANY, Limited, Marshgate-lane, Stratford, E. 15.—Desk blotter, with the months of the year printed on each sheet of blotting paper.

BELDAM PACKING AND RUBBER COMPANY, LIMITED, 29, Gracechurch-street, E.C. 3.—Wall calendar with monthly tear-off sheets, with a colour picture of ships.

CHARLES LAIDLOW, Braefoot, Crook of Devon, Kinrossshire.—Copy of Laidlow's practical speed and feed guide and diary for 1925, which is published at 2s. net.

CONTRACTS.

BEDFORD ENGINEERING COMPANY, of Bedford, has received an order from the India Store Department for two large electric goliath cranes, of 5 and 15 tons capacity, running on rails 60ft. span.

THE Manchester Corporation has placed a repeat order with the General Electric Company, Limited, for twenty-four standard box-frame self-ventilated interpole type tramway motors, type W.T. 32A, fitted with roller bearings and rated at 40 horse-power.

WE learn that the cable ship Faraday, which belongs to Siemens Brothers and Co., Limited, left that company's works at Woolwich last Saturday afternoon loaded with 1500 miles of submarine cable, to be laid for the new Italian Cable Company between Cape Verde Islands and the Island of Fernando Noronha, a small island off the coast of Brazil. Messrs. Siemens Brothers are, we understand, now engaged on the manufacture of 1700 miles of cable to form the continuation of this Italian company's system from Fernando Noronha south to Rio de Janeiro.

CRYSTAL PALACE SCHOOL OF ENGINEERING.—On Wednesday last Dr. John S. Owens, Assoc. M. Inst. C.E., addressed the students of the Crystal Palace School of Engineering, and distributed the certificates. He remarked upon the contrast between school training, with its absence of heavy responsibility, and professional practice in which responsibility and financial consideration were prominent. He impressed upon them that their training was intended to enable them to accept such responsibility faithfully. He also advised them to specialise when possible, saying that the accumulated mass of knowledge was so great that no man could hope to master many subjects. In conclusion, he impressed upon his listeners the human side of their problems; they always involved, he said, relations with other people, and they should be made upon mutual confidence and strictly upright behaviour.

GAUGE TESTING.—We have received from the National Physical Laboratory a copy of the Laboratory Test Pamphlet on Gauge Testing, which has just been revised. It deals with the tests of various types of gauges and measuring apparatus usually to be found in inspection rooms and workshops. As far as possible limits of accuracy have been laid down for such gauges and instruments. If found to comply with these limits, of which there are sometimes two grades, the gauge or instrument is granted a certificate and receives the Laboratory mark of approval. If required, the Laboratory is also prepared to test and certify gauges and measuring instruments made to special schedules of limits or specifications supplied by the manufacturer or user. This scheme is outlined on page 5 of the pamphlet. The pamphlet contains details of the measurements that can be made and of the fees charged, and copies may be obtained on application to the Director, National Physical Laboratory, Teddington.

STANDARD KEYS, KEYWAYS AND KEYBARS.—The British Engineering Standards Association has just issued, in its usual octavo form, Publication No. 46, Part 1–1924, Tables of Dimensions for Rectangular and Square Parallel Keys, Keyways and Keybars. On comparing these tables with the table in the Association's original Publication No. 46–1909, it will be seen that they have been extended to include keys for shafts down to $^{9}/_{16}$in. in diameter, the largest size still remaining at 12in., and that the shaft sizes have been divided into a greater number of ranges; in other words, the range of sizes for which each key is recommended has been reduced. The latter alteration, which has been made in order to bring the recommendations of the Association more into line with modern practice, should, coupled with the extension of the tables, considerably enhance the usefulness of the publication to the industry. The tables are accompanied by notes regarding the rounding of the corners of the keys and keyways, the depth of immersion, the fit of the keys in the keyways, &c.; full dimensions of the keyway with tolerances are given in addition to similar details for the key and keybar, so that all information required for the production of interchangeable keys and keyways would seem to be provided. These tables form part of the general revision of Publication 46–1909 with which the Committee is proceeding. The second and concluding part is expected to contain tables of dimensions for keys of other forms, tables of taper keys being indeed already in preparation, a section dealing with nomenclature and general notes. It is hoped that this will be issued early next year. Copies of the Publication (No. 46, Part 1–1924) may be obtained from the B.E.S.A., Publications Department, 28, Victoria-street, London, S.W. 1, price 1s. 2d. post free.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	17/6 to 24/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 15 0	—
No. 1 Foundry	4 15 0	—
No. 3 Foundry	4 10 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 8 6	4 8 6
No. 1	4 9 0	4 9 0
Cleveland—		
No. 1	4 6 6	4 6 6
Silicious Iron	4 6 6	4 6 6
No. 3 G.M.B.	4 1 6	4 1 6
No. 4 Foundry	4 0 6	4 0 6
No. 4 Forge	4 0 0	4 0 0
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
„ „ Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 16 0 to 3 17 0	
„ Forge	3 11 0	—
(3) Derbyshire—		
No. 3 Foundry	4 2 6	—
Forge	3 16 6 to 3 17 6	
(3) Lincolnshire—		
No. 3 Foundry	4 2 6	—
No. 4 Forge	4 0 0	—
Basic	4 5 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	5 2 6 (a) / 5 7 6 (b)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 0 0	—
Best „	—	—
N.E. COAST—		
Common Bars	12 0 0	—
LANCS—		
Crown Bars	13 0 0	—
Second Quality Bars	12 0 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	13 0 0	—
Best „	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	12 15 0	—
Marked Bars (Staffs.)	15 0 0	—
Nut and Bolt Bars	11 15 0	—
Gas Tube Strip	13 5 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	13 0 0	—
Ship Plates, ¼in. and up	9 15 0	—
Sections	9 10 0	—
Steel Sheets, 3/16in. to ¼in.	12 0 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	9 15 0	—
Angles	9 10 0	—
Boiler Plates	13 0 0	—
Joists	9 10 0	—
Heavy Rails	9 0 0	—
Fish-plates	13 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	9 10 0	—
Soft Billets	8 10 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 0 0†	—
Light „	9 5 0 to 9 10 0	
Billets	8 0 0 to 11 10 0†	
MANCHESTER—		
Bars (Round)	10 0 0 to 10 10 0	
„ (others)	9 15 0 to 10 0 0	
Hoops (Best)	15 5 0	15 0 0
„ (Soft Steel)	13 15 0	13 10 0
Plates	9 15 0 to 10 0 0	
„ (Lancs. Boiler)	13 0 0	—
SHEFFIELD—		
Siemens Acid Billets	11 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	9 10 0	
Intermediate Basic	9 0 0	
Soft Basic	8 0 0 to 8 5 0	
Hoops	12 0 0	—
Soft Wire Rods	11 0 0 to 11 10 0	
MIDLANDS—		
Small Rolled Bars	9 5 0 to 10 0 0	
Billets and Sheet-bars	7 10 0 to 7 15 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 7 6 to 17 10 0	
Angles	9 5 0	—
Joists	9 5 0	—
Tees	10 5 0	—
Bridge and Tank Plates	9 15 0	—
Boiler Plates	13 10 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	23/6 to 23/7½
Block Tin (cash)	261 5 0
„ (three months)	264 10 0
Copper (cash)	85 12 6
„ (three months)	86 12 6
Spanish Lead (cash)	42 10 0
„ (three months)	39 12 6
Spelter (cash)	37 12 6
„ (three months)	37 3 9
MANCHESTER—	
Copper, Best Selected Ingots	71 0 0
„ Electrolytic	71 10 0
„ Strong Sheets	96 0 0
„ Tubes (Basis price)	0 1 1½
Brass Tubes (Basis price)	0 1 0½
„ Condenser	0 1 2½
Lead, English	45 0 0
„ Foreign	43 10 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/8½ per lb.	
Ferro Tungsten	1/4½d. per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	8/-
„ 6 p.c. to 8 p.c. „	£23 10 0	7/9
„ 8 p.c. to 10 p.c. „	£23 0 0	7/6
„ Specially Refined		
„ Max. 2 p.c. carbon	£43 0 0	16/-
„ „ 1 p.c. „	£52 0 0	17/6
„ „ 0.75 p.c. carbon	£60 0 0	20/-
„ „ carbon free	1/5 per lb.	
Metallic Chromium	4/2 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 15 0 scale 5/- per unit	
„ „ 75 p.c.	£17 17 6 scale 6/- per unit	
„ Vanadium	17/6 per lb	
„ Molybdenum	7/9 per lb.	
„ Titanium (carbon free)	1/2 per lb	
Nickel (per ton)	£165	
Cobalt	10/- per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	16/9
„ „ Ell	19/9
„ „ Splint	22/6 to 23/-
„ „ Trebles	19/3
„ „ Doubles	18/6
„ „ Singles	15/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	16/9
„ „ Splint	22/6
„ „ Trebles	19/3
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	15/1½ to 18/-
Screened Navigation	24/6
Trebles	21/-
Doubles	19/-
Singles	15/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	18/3
Secondary Steam	17/3
Trebles	20/-
Doubles	19/-
Singles	14/-

ENGLAND.

(8) N.W. COAST—	
Steams	28/6
Household	45/- to 58/4
Coke	30/-
NORTHUMBERLAND—	
Best Steams	18/6 to 18/9
Second Steams	17/6 to 18/-
Steam Smalls	10/6 to 10/9
Unscreened	15/6 to 17/-
Household	23/6 to 25/-
DURHAM—	
Best Gas	21/6
Second	18/3 to 18/6
Household	23/6 to 25/-
Foundry Coke	23/- to 24/6
SHEFFIELD—	Inland.
Best Hand-picked Branch	32/- to 35/- —
Barnsley Best Silkstone	26/- to 28/- —
Derbyshire Best Brights	27/- to 32/- —
„ „ House	24/- to 26/- —
„ „ Large Nuts	22/6 to 25/- —
„ „ Small	14/- to 16/- —
Yorkshire Hards	20/6 to 23/- —
Derbyshire „	20/6 to 22/6 —
Rough Slacks	9/6 to 12/- —
Nutty „	8/6 to 10/6 —
Smalls	4/- to 6/6 —
Blast-furnace Coke (Inland)*	— —
„ „ (Export)	f.o.b. 21/6 to 22/6

	(9) SOUTH WALES.
CARDIFF—	
Steam Coals:	
Best Smokeless Large	27/6 to 28/-
Second „ „	26/- to 27/-
Best Dry Large	27/- to 27/6
Ordinary Dry Large	24/- to 26/-
Best Black Vein Large	24/6 to 25/-
Western Valley „	23/6 to 24/6
Best Eastern Valley Large	23/6 to 24/6
Ordinary „ „	22/6 to 23/-
Best Steam Smalls	16/- to 18/-
Ordinary „	13/- to 16/-
Washed Nuts	22/- to 32/-
No. 3 Rhondda Large	27/- to 27/6
„ „ Smalls	19/- to 20/-
No. 2 „ Large	22/6 to 23/6
„ „ Through	18/- to 20/-
„ „ Smalls	11/- to 13/-
Foundry Coke (export)	40/- to 47/6
Furnace Coke (export)	27/6 to 32/6
Patent Fuel	25/6 to 27/-
Pitwood (ex ship)	32/- to 32/6
SWANSEA—	
Anthracite Coals	
Best Big Vein Large	47/6 to 50/-
Seconds	40/- to 45/-
Red Vein	34/- to 36/-
Machine-made Cobbles	59/- to 60/-
Nuts	55/- to 60/-
Beans	44/- to 45/-
Peas	19/- to 23/-
Breaker Duff	9/3 to 9/9
Rubbly Culm	11/6 to 12/-
Steam Coals:	
Large	22/6 to 23/6
Seconds	22/- to 22/6
Smalls	14/- to 16/-
Cargo Through	17/- to 19/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast furnaces only, 16/9, with fluctuations according to analysis; open market, round about 22/6 to 25/- at ovens. † Latest quotations available. (a) Delivered Sheffield or Glasgow. (b) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Trade Decline.

WHILE it cannot be said that trade is in a state of actual depression, there are, nevertheless, many indications that it is rapidly declining, and is now bordering upon something like a crisis. In several branches of industry a number of men have been discharged, and the fact of unemployment becoming, for the first time, a serious factor, has raised the question whether it will not be necessary to restrict the number of foreigners employed in works. So long as the demand far exceeded the supply, special arrangements were made for importing labour from Poland, Czecho-Slovakia and other countries, and now that there is a general setback in trade the prospect of this competition of foreign labour has rendered it necessary to provide for the interests of French workers. It is quite possible that the falling off in activity may be largely due to the usual restriction of buying towards the end of the year, and it is most marked in industries which are more or less of a seasonable character; but it is, nevertheless, feared that it will be very difficult for trade to recover in view of the depressing influences under which it is now labouring. Not only are manufacturers steadily increasing their charges, and must continue to do so in view of the additional taxes imposed upon them, but they have to give much longer credits, with the result that more capital is needed to carry on business. At the present moment capital is hardly procurable, and money can only be obtained at a very high rate of interest. The exchange rate is another disquieting factor. There is no sign yet of stabilisation, and, contrary to previous experience, the depreciation of the franc has not been accompanied by a larger demand on export account. It is certain that the competition for the business given out is seriously affecting prices. Complaints are made that State and other contracts are accepted under conditions that leave little or no profit, merely for the sake of providing employment.

Strikes.

The conditions under which the labour agitation is taking place in Belgium are so similar to what they are in this country that an extension of the movement is quite possible, unless opportunities are given to French manufacturers to obtain some compensation for higher wages in the prices they obtain for their products. Living costs are steadily increasing, and in Belgium engineering firms in the province of Brabant have declared that a lock-out will follow upon the refusal of the men on strike to return to work. All over Belgium manufacturers have decided to resist further claims for higher wages. They state that in the present condition of international trade they are unable to pay more to the men. In France, where the home trade has been very active until the last few months, wages have been steadily advancing, but they have now reached a limit beyond which it is found impossible to go. The Government is making every effort to prevent any further inflation of living costs, with apparently no better result than the efforts of previous Governments, and the idea of the new Tariff Bill in lowering the duties on certain indispensable products and machines, with a view of cheapening production, is regarded as seriously detrimental to corresponding home industries, although most other branches will receive more protection.

Naval Programme.

The new naval programme, providing for a complete reorganisation of the navy on a definite basis, has now been completed, and will shortly be introduced into the Chamber of Deputies. When the first instalment of naval construction was put in hand, the general lines of the Naval Statute, as it is called, were already laid down, and it has since been elaborated with a view of ensuring the rapid and economical construction of vessels which will constitute a homogeneous and efficient fleet. As nothing is said about the construction of capital ships, it is probable that the preferences of a large section of naval opinion have been set aside in deference to the generally accepted idea that the special requirements of France can only be met chiefly by fast cruisers and submarines. The Minister of the Marine has referred especially to the importance which will be given to under-water craft. It is hoped to make them sufficiently powerful to combat enemy cruisers, and, with the co-operation of seaplanes, to ensure communication between France and North Africa.

New Motor Fuel.

A great deal of official secrecy is observed over trials that are being carried out at Vincennes on the heaviest types of military tractors with an installation for producing spirit from crude oil, invented by a Russian engineer, M. Makhonine. The separation is apparently effected on the vehicle itself, and the value of the process lies in its simplicity. It is claimed that the spirit is produced at one-tenth the cost of petrol. The problem of finding new sources of motor fuel is of such primary importance to this country, that every new process raises hopes that are not always justified by results, and little can be known of the actual value of the Makhonine system of separating light oils from crude petroleum until the trials are terminated.

Aviation.

So heavy is the cost of subsidising aeroplane factories that the Government was reported to have recommended the amalgamation of the small makers with the big firms. The Show in Paris has brought so many orders for machines that the situation of builders has changed for the better. Makers of aviation engines are particularly favoured. One of the leading firms has stated that it has orders in hand or in prospect to the value of 200 million francs.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

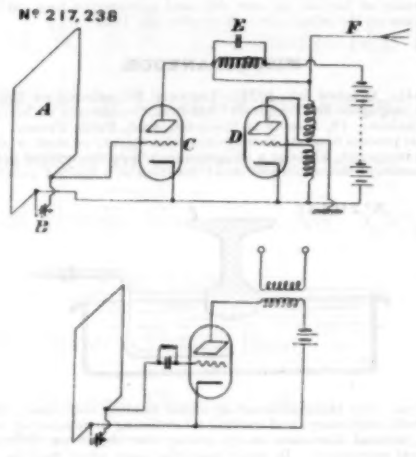
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TELEGRAPHS AND TELEPHONES.

217,238. June 5th, 1924.—IMPROVEMENTS IN DIRECTIONAL RECEPTION AND TRANSMISSION IN WIRELESS TELEGRAPHY, Marius Latour, of 8, Square Desaix, Paris.

A large part of this specification is devoted to the principles on which the invention is based, but the two accompanying diagrams show the scheme which is finally described. The upper diagram shows how reception of long waves on a frame may control a local transmission of small wave lengths. The frame A with an adjustable capacity B receives the current of long wave length from a distant station. This current is amplified by the valve C. The amplified potential which is obtained at the terminals of the oscillating circuit E is used to modulate the plate potential of the generator valve D, which feeds the aerial F. The lower diagram shows the scheme for the reception of the currents of short wave length, modulated by the received current of longer wave length from a distant station. After detection, the reception of the current of short wave length reproduces the

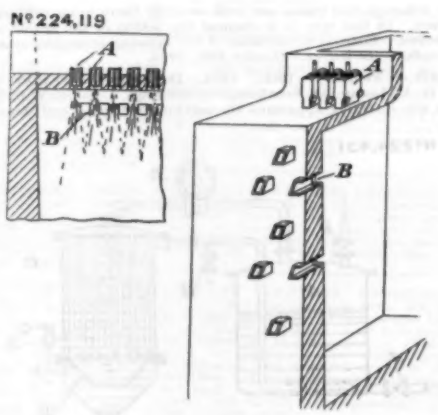


reception of the current of long wave length. The transmission from one receiving frame to another being made by wireless will be effected at the velocity of light. Transmission and reception of short waves may also be directive. For directional transmission, successive stations are aligned in the required direction and spaced apart by an uneven number of quarter wave lengths in such a way that the transmissions at the same frequency may be de-phased with regard to time by an amount corresponding to their displacement in space, so as to secure a cumulative effect at the point of reception. The necessary energy for working these different stations can be distributed by a line conductor for the transmission of high-frequency energy, but it is possible to control the different transmissions for maintaining the necessary phase by wireless telegraph stations working directly with high frequency.—*November 3rd*, 1924.

FURNACES.

224,119. January 3rd, 1924.—COMBUSTION OF PULVERISED FUEL, The Underfeed Stoker Company, Aldwych House, Aldwych, London, W.C. 2, and W. R. Wood.

This invention is claimed to ensure ignition of the fuel as soon as is practicable after it has left the burners without disturbing its vertical direction, by using what may be called fish-tail burners, that is to say, burners having nozzles longer than they are broad, and arranging them with the longer axis at right angles to the front wall of the furnace, and by providing air

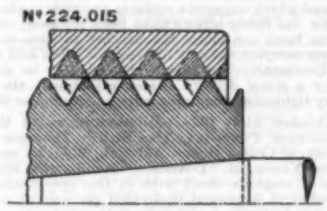


ports in the front wall at the level of the burners and between them. The fuel issues from the burners in thin sheets which gradually spread out and intermingle; according to the invention the air enters between these sheets while they are still separate. In this manner plenty of air is provided on each side of the mouth of the burner to ensure ignition, while there is little or no disturbance of the downward course of the fuel. In the drawing A A are the burners and B B the air ports.—*November 6th*, 1924.

MACHINE TOOLS AND SHOP APPLIANCES.

224,015. August 15th, 1923.—SCREW CUTTING, E. Baumann, 22, Rathausufer, Dusseldorf, Germany.

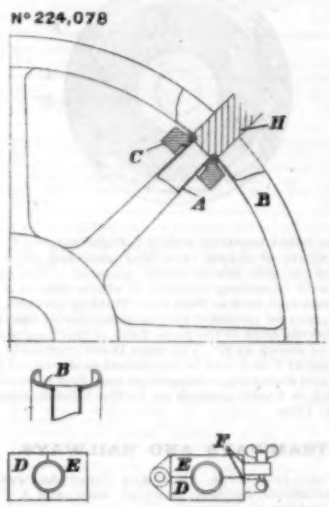
It is stated in this specification that the tool generally used in screw cutting is usually moved in an axial direction in relation to the work, and in consequence of the feed movement and the form of the cutting tool (screw tap), the whole screw profile of one or more threads is worked. The tool cuts both sides of the thread simultaneously and thereby a very unsatisfactory cut is made, for the metal removed is of angular form in cross section and thus there is difficulty in smoothly separating it



from the work. The consequence of this is a tearing cut and much waste. The new method consists in cutting the screw threads simultaneously and on one face only, in one working course, the work or the tool being held stationary during the cutting stroke and in causing the feed movement to be effected obliquely and substantially in the direction of the sides of the screw thread instead of radially. The result is a flat and smooth cut in each thread. The illustration indicates the method of feeding the tool, and the specification includes a description of a screw-cutting machine embodying the idea.—*November 6th*, 1924.

224,078. October 20th, 1923.—AN IMPROVED ELECTRICAL WELDING PROCESS, The Dunlop Rubber Company, Limited, 1, Albany-street, Regent's Park; and John Thomas Turney Randles, of Fort Dunlop, Erdington, Birmingham.

This specification describes a method whereby the flanged or bell-mouthed end of a hollow tubular metal member may be conveniently welded to any other metal member provided with a hole or aperture to receive the end of the tubular member. The invention is particularly applicable to the manufacture of metal wheels of the type in which a tubular metal spoke is welded to the rim or felloe. Referring to the drawings, a tubular bell-mouthed spoke A is fitted within an aperture in a rim B in the position in which it is desired to be welded or is fitted on the

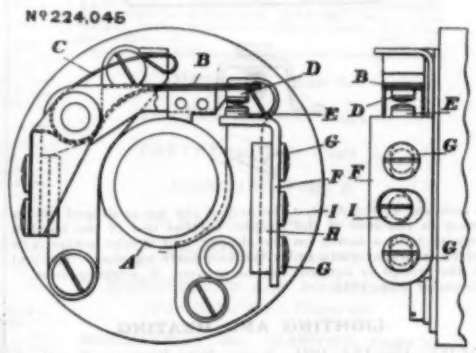


outside of the flange formed around the aperture. An annular electrode C is placed around the extremity of the tubular spoke adjacent to the part to be welded. The annular electrode is constructed in two parts, one part D being fixed to the welding machine and the other part E being movable. One method of constructing the annular electrode is shown in the lower right-hand drawing in which the fixed part D is attached to the welding machine and the moving part E is attached to the part D by means of a hinge at one end, the two portions being held securely together by means of lugs F with a bolt and nut as shown. A second electrode H is applied to the mouth of the tubular spoke A and is shaped so as to fit over that portion of the spoke which is to be welded to the rim B.—*November 6th*, 1924.

MOTOR CARS AND ROAD TRAFFIC.

224,045. September 19th, 1923.—IMPROVEMENTS RELATING TO ELECTRIC CURRENT INTERRUPTERS FOR IGNITION MAGNETOS, COILS, AND LIKE APPARATUS, The L.M. Magneto Syndicate, Limited, and Ernest Ansley Watson, all of Victoria Works, West Orchard, Coventry.

The object of this invention is to provide improved means for

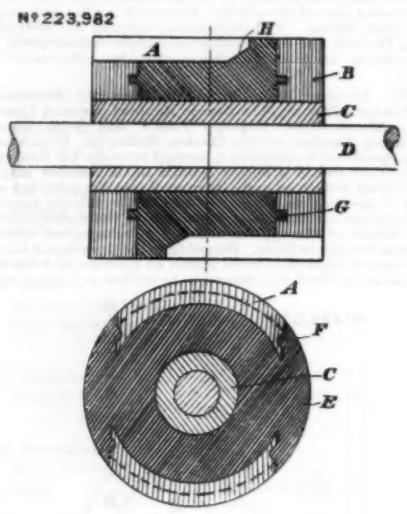


the electric adjustment of the contact pieces. Usually the fixed stationary contact piece is mounted or formed on a screw and is adjusted by rotating the screw relatively to the part which carries it. It has been proposed to carry the contact piece on a

support which can be adjusted by a sliding movement. In its improved construction a slidable support for the fixed or stationary contact is employed and the adjustment is effected by an excentric device. In the application of the invention as shown the stationary interrupter, which is actuated by a rotating cam A, comprises a lever B controlled by a spring C and carrying the movable contact piece D. The stationary contact piece E is secured to a rigid support or carrier F in the form of a bracket which is preferably made by bending a metal strip so that the upper portion is at right angles to the other. The contact piece is fixed to the upper portion, and through the other portion of the bracket screws G are inserted which secure the bracket in position on the fixed part H on the interrupter. Through the portion which receives the fixing screws a screw I is inserted having an excentric head which engages a suitable aperture in the bracket, so that, after the fixing screws have been released, rotation of the excentric head can cause the bracket to slide towards or from the lever carrying the movable contact piece and effect the required adjustment. The excentric head may be slotted for actuation by a screw driver. After adjustment the bracket is secured by tightening the fixing screws.—*November 6th*, 1924.

223,982. October 31st, 1924.—IMPROVEMENTS IN MAGNETOS FOR IGNITION PURPOSES, The British Thomson-Houston Company, of Crown House, Aldwych, W.C. 2; and Arthur Primrose Young, of "Dovedale," Kenilworth, Warwick.

The type of magneto dealt with in this specification has a rotor composed of a coaxial undivided permanent magnet of tubular form and provided with poles acting in conjunction with a single stationary armature coil. The object of the invention is to provide a laminated form of rotor of this type which is simple and cheap to manufacture. The laminated induction fingers are shown at A. There may be two, four, six, or more of these fingers, and they are secured to the ring pole piece B.

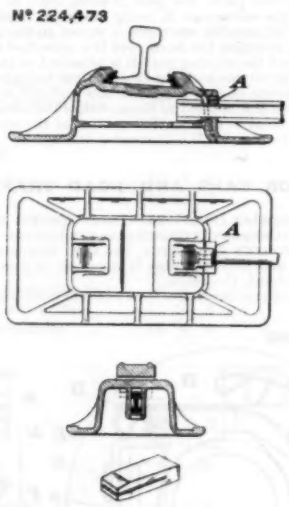


They are mounted together with a tubular magnet C, which is preferably made of cobalt steel and mounted on a shaft D composed of suitable non-magnetic material. The cylinder is completed with insulating material E which may be a moulded insulating material, such as Bakelite. Holding recesses, as shown at F and G, may be provided for the reception of the insulating material, and the ends of the inner faces of the fingers A may be levelled off as shown at H. The rings B are preferably mounted upon the magnet C and may be laminated as shown. The fingers A, rings B, and insulating composition may first be moulded into a tube which is finally pushed on to the tubular magnet C.—*October 31st*, 1924.

TRAMWAYS AND RAILWAYS.

224,473. June 10th, 1924.—RAILWAY SLEEPERS, Guest, Keen and Nettlefolds, Limited, Newport, Mon., and J. P. Bayley, 4, Westfield-road, Newport.

This sleeper is of the cast iron "pot" type, and the invention is chiefly concerned with the means for securing the tie bar which connects each pair of sleepers. The tie is of I section, and

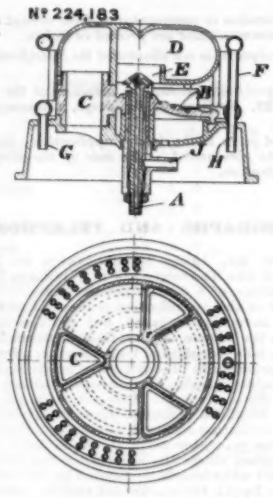


is notched at the ends. The end of the tie is slipped into a recess in the side of the sleeper, so that one of the notches engages with a facing on the sleeper, and a split wedge A is driven in transversely to fix the two parts together. The end of the wedge is opened out to prevent it working loose.—*November 13th*, 1924.

LIGHTING AND HEATING.

224,183. June 13th, 1924.—LIQUID FUEL BURNERS, N. Galassi, Silvani 4 ter, Bologna, Italy.

In this burner the oil is supplied through a duct A and is spread by a conical head over the corrugated disc B. Air is conducted through the disc by passages C into the chamber D and escapes by the central opening E above the spray of oil coming from the conical head. The resultant mixture spreads radially to form a flame. Water is introduced into the tubular cage F at G and, after being evaporated, is taken from H to J,

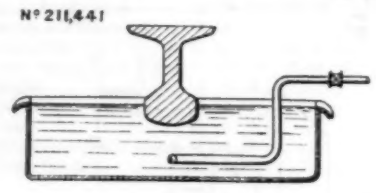


so that it spreads beneath the spray of fuel. The basic idea of the invention appears to be the production of a spray of fuel with a curtain of hot air on one side and a corresponding curtain of steam on the other side.—*November 6th*, 1924.

MISCELLANEOUS.

211,441. October 6th, 1923.—THERMIC TREATMENT OF STEEL, Compagnie des Forges de Châtillon, Commentry et Neuves-Maisons, 19, Rue de la Rochefoucauld, Paris, France.

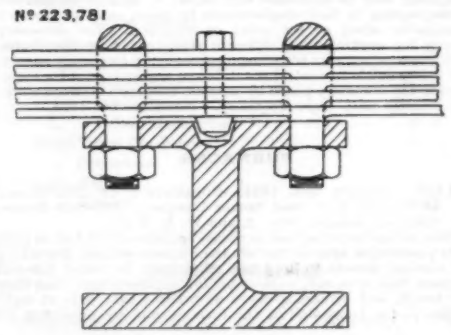
This process consists in subjecting the objects of steel or alloy to be tempered, while at a temperature above the critical point, to a series of immersions of short duration in a limited quantity



of liquid, this being effected by either holding the object, such as a rail, stationary, and moving a hardening or tempering bath in a vertical direction or by giving the object an alternate vertical movement. In some cases the same effect may be obtained by merely altering the height of the cooling liquid in the bath. The cooling liquid is supplied by the pipe shown, so as to make up for evaporation.—*October 30th*, 1924.

223,781. January 11th, 1924.—LAMINATED SPRINGS, Société Anonyme des Automobiles Unic, 1, Quai National, Puteaux, Seine, France.

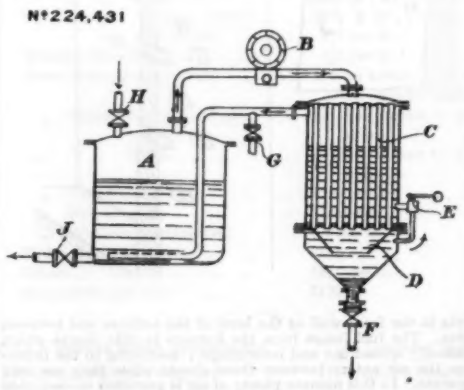
The inventors propose to make the leaves of laminated springs with bosses, as shown in the drawing, in way of the clips, so



that although the leaves are held securely there is no rubbing contact. In this way it is claimed the action of the spring is improved. There is no mention of any spacing arrangement at the ends of the leaves.—*October 30th*, 1924.

224,431. February 19th, 1924.—DISTILLING APPARATUS, O. Y. Imray, 30, Southampton-buildings, London, W.C. 2.

In this distilling apparatus the mixture of vapour and steam



issuing from the still A, which has an inlet H and a discharge J, is forwarded under compression by the pump B into the condenser C, where it liquefies. The condensate collects in the separating chamber D, from which the separated volatile body is discharged at F. The liquefied expelling agent, for instance, water, flows through the loaded valve E to serve as cooling agent in the condenser C, where it absorbs the heat of condensation, while it is itself re-evaporated to return to the still A. The decrease of temperature required for this exchange of heat is due to the fall of the saturation temperature—for instance, to 10 deg. Cent., corresponding with reduction of the vapour pressure. G is the inlet for the steam for heating the apparatus.—*November 13th*, 1924.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

TO-DAY.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Watergate House, Adelphi, London, W.C. 2. London Graduates' meeting. Paper, "Tooth Gearing," by Mr. H. E. Merritt. 7.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "Locomotive Valves and Valve Gears," by Mr. J. W. Baldock. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Second Report of the Wire Ropes Research Committee. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, Westminster, London, S.W. 1. Lecture, "Aircraft in Japan, Preceded by a Few Experiences of the King's Cup Race, 1924," by Colonel the Master of Sempill. 7.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—The Engineers' Club, Manchester. Paper, "The Manufacture and Uses of Stainless Iron," by Mr. H. S. Primrose. 7.15 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Bolbec Hall, Newcastle-upon-Tyne. "Theory of Longitudinal Bonding of Ships," by Mr. J. Lockwood Taylor. 7.30 p.m.

SATURDAY, DECEMBER 20TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—London Graduates' visit to the works of J. A. Prestwich and Co., Limited, Northumberland Park, Tottenham. 2.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Students' visit to the London Station of the British Broadcasting Company. 6.15 p.m.

TUESDAY, DECEMBER 23RD.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Society of Motor Manufacturers and Traders, 83, Pall Mall, London, S.W. 1. Informal meeting. Demonstration and discussion on "Anti-dazzle Devices." 6.30 p.m.

1925.

FRIDAY, JANUARY 2ND.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecturette, "Modern Flour-milling Machinery," by Mr. W. Ringrose. 7.30 p.m.

FRIDAY, JANUARY 9TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster, London, S.W. 1. Informal meeting. "The Maintenance of High-compression Oil Engines." 7 p.m.

MONDAY, JANUARY 12TH.

INSTITUTE OF TRANSPORT: YORKSHIRE LOCAL SECTION.—Town Hall, Leeds. Inaugural address by the Chairman, Mr. J. B. Hamilton. 5.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE are informed that the Lord Askwith, K.C.B., has consented to be the president of the Institute of Patentees for the year 1925–1926.

MESSRS. JOHN TAYLOR AND SONS, consulting engineers, have removed their offices from 36, Victoria-street, to Caxton House (East Block, 3rd Floor), Westminster, S.W. 1.

WE are informed that Mr. J. M. Morton has been appointed repair works manager to the shipbuilding and engineering works of Cammell Laird and Co., Limited, at Birkenhead.

DR. W. R. COODE ADAMS, M.A., M.Sc., Ph.D. (Camb.), B.Sc. (London), A.I.C., has been appointed an assistant lecturer and demonstrator to Faraday House Electrical Engineering College.

GEORGE ELLISON, of Perry Barr, Birmingham, informs us that he has appointed Lieut.-Colonel F. W. Foster, M.C., late of the English Electric Company, Limited, manager of his branch office at Manchester, the address of which is 78, King-street.

JAS. MILNE COOPER AND CO., Limited, of 1, Cheapside, Bradford, ask us to announce that they have extended their works on a new site, and that from the first day of January, 1925, their offices and works address will be Kobar Works, Ambler-street, Bradford. Telephone, 4438; telegrams and cables, "Zanoline, Bradford."

WE are advised that the controlling interest in Ruths Steam Accumulator Company, Limited, has been acquired by the Fairfield Shipbuilding and Engineering Company, Limited, and James Howden and Co., Limited, of Glasgow. The company was formed in April last for the purpose of marketing in the British Empire the steam accumulator invented by Dr. J. Ruths, of Stockholm. By the terms of the licence all plants will be made in this country.

THE SOCIETY OF ENGINEERS.—The following awards of premiums for papers in 1924 have been announced:—President's Gold Medal, to Mr. James Jackson, for his paper on "Development of Methods for the Collection and Disposal of House (Domestic) Refuse;" Bessemer Premium, value £5 5s., to Mr. H. A. Rickwood, A.M.I.E.E., for his paper on "Recent Developments in Ferro-concrete Cooling Towers;" Nursey Premium, value £3 3s., to Captain W. J. Liberty, for his paper on "Underground London."